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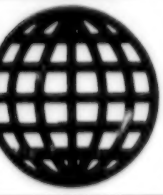

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SSTV Transmitter

927K0239A Moscow RADIO in Russian No 1, Jan 92 pp 15-17

[Article by V. Vasilyev, Samara]

[Abstract] This article describes a device which converts the image in a frame into an electrical signal for satellite television. The scanning procedure and synchronization are described, as are the amplification and modulation circuitry. The specific features of construction and components are detailed. This article enables the hobbyist to build this type of system. The necessary schematics are presented, as well as illustrations to indicate the organization of the subsystems of the transmitter. Figures 4; references 3 (Russian).

Electronic Lighter

927K0239B Moscow RADIO in Russian No 1, Jan 92 pp 19-21

[Article by I. A. Nechayev]

[Abstract] This article instructs the hobbyist how to build two versions of a device to light the burners of a gas stove. One is an electric device, the other is battery-operated. The device generates a spark to light the gas. Schematics are given. The article also explains how the device works. Figures 4; reference 1 (Russian).

Magnetic Slit Detectors DMI-1 and DMI-2

927K0239C Moscow RADIO in Russian No 1, Jan 92 pp 29-31

[Article by M. Baranochnikov, Yu. Kolesov and V. Smirnov, Moscow]

[Abstract] This article describes the construction and circuitry of two magnetic slit detectors. Hall elements and magnetically-controlled microcircuits are used. They are mass produced, and are used to determine the position of a moving object. They are also used in a contactless electric ignition system for engines in light automobiles. The DMI-1 detector is the analog of the Honeywell 1AV2A and 1AV10A sensors. The advantages of magnetic sensors over other types of sensors are outlined. This relatively simple detector can be used in machine construction, robotics and other fields. Figures 5; table 1; references 7 (Russian).

Structure of the Design of Television Camera Mechanisms

927K0225A Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 1, Jan 92 pp 19-23

[Article by V. A. Kudryavtsev; UDC 621.397.424.001.24]

[Abstract] As cameras become more complex, greater demands are made on their components. Automation can now be used to design the mechanisms of a television camera, calculating the parameters and operating capabilities of mechanisms with a computer program. Analytical work done at each stage of design should be systemized with subsequent development of a transparent structure of the deisgn calculations from the stage of analysis of technical requirements to the issuing of technical documentation. The subsystems of the camera are classified and their parameters defined. Then the procedure for selecting particular parts (i.e., gears, motors of a certain speed) for each subsystem, and how the selection of a particular component affects other components and systems are outlined in great detail. This detailed analysis lays the groundwork for the development of an automated design tool. Figures 4; table 1; references 12 (Russian).

Television: How Much Does Intellectual Property Cost?

927K0225B Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 1, Jan 92 pp 28-38

[Article by A. P. Barsukov; UDC 621.397.13:342]

[Abstract] This article takes the reader on a meandering tour of various aspects of the protection and exploitation of intellectual property. It begins with an examination of immigration policies to encourage immigration or prevent emigration of talented professionals. The focus then turns to the issue of licensing, and how groups may design legislation to protect their own interests, either by restricting privileges to their own group or by taking a cut of profits. The example of cable television is used, and the rights and responsibilities of those who receive cable television licenses are discussed. An appendix details the rights and responsiblities extended in this case in various countries. The concepts of monopolies and oligopolies are discussed, as well as cases where monopolies are legal and unavoidable. The concept of a "temporary monopoly" as it applies to creative work is analyzed. Punishment of crimes infringing upon the rights of intellectual property are outlined. The subject of agents to represent creative people and the formation of joint-stock companies is addressed.

New Legislation on the "Capitalization" of Intellectual Property

927K0225C Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 1, Jan 92 pp 65-68

[Abstract] The importance of the protection of the rights of innovators is discussed. The new Law on Inventions in the USSR is said to bring the USSR in line with world practice in patent law, and the importance of standardizing the protection of intellectual property on a worldwide basis is stressed. This article also acquaints the reader with the information presented at the conference entitled "Patent Legislation as a Factor in Stimulating Innovative Activity and the

Development of Competition." It was held 1-4 October 1991 in Moscow. The following reports are discussed: the role of industrial property in the organization of the innovation process, selection of an innovation strategy to use inventions, prospects for the development of innovation activity in Russia, specifics of the legal protection of industrial models in the transition to market relations, problems of patent formation in the new economic conditions, some aspects of the organization of a patent court in the USSR and legal procedure in patent issues, protection of inventions in the transition to a market economy, examples of organizations working with intellectual property, and foreign business experience with intellectual property. In addition, the issue of video cassette piracy is addressed.

Use of Artificial Inhomogeneities in Ionosphere for Generating Parametric Thermal Instabilities During Oblique Excitation

927K0256A Nizhniy Novgorod IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 34 No 6, Jun 91 (manuscript received 26 Mar 90) pp 624-629

[Article by L.M. Yerukhimov and M.M. Shvarts, Scientific Research Institute of Radiophysics; UDC 551.510.535]

[Abstract] The feasibility of heating an ionospheric plasma by excitation with an obliquely incident beam of electromagnetic radio waves from a remote transmitter and their scattering into the region of plasma resonances by artificial inhomogeneities in the ionosphere is analyzed, artificial plasma inhomogeneities being considered which spread in the direction of the geomagnetic field and form "lattices" with wave vectors perpendicular to that field. The distortion of the permittivity profile of the thus stratified ionospheric plasma is proportional to the scalar product of two electric field vectors, that of the incident wave and that of the scattered wave. This scalar product can be and is resolved into two factors, one accounting for modulation of the permittivity fluctuation in the fields of both incident and backscattered waves and one characterizing the distortion of the permittivity profile by stimulated thermal scattering "lattices" with different wave numbers. The intensity of the once only scattered electric field is then calculated from the solution to applicable nonhomogeneous Maxwell equations, using Greens' functions for expansion into series of perturbation theory in the case of small fluctuations. Owing to refraction of the scattered field, radiation into the region of upper-hybrid plasma resonance propagates within a 12° cone about the vertical. Numerical estimates pertaining to scattering in a vertical plane, with the constraints of aspect taken into account, indicate that formation of a stimulated thermal scattering "lattices" and its scattering an excitation power of 100-200 MW will ensure development of an artificial ionospheric turbulence. Figures 1; references 4.

Radiophysical Methods of Noncoherent Remote Sea Surface Probing

927K0256B Nizhniy Novgorod IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 34 No 6, Jun 91 (manuscript received 14 Mar 90, collated version received 30 Jul 90) pp 630-638

[Article by Bakhshyan, G.I Marinosyan, and K.S. Mosoyan, Central Scientific Research Institute "Kometa", Yerevan branch; UDC 551.526.535.214]

[Abstract] Emission and scattering of either horizontally or vertically polarized SHF radio waves by a rough sea surface are analyzed theoretically on the basis of Fyng's two-scale model (A.K. Fyng; GEOPHYSICS RESEARCH Vol 77 No 30, 1972; Vol 82 No 24, 1977; PROCEEDINGS IEEE Vol 67 No 11, 1979), for calculation of the mean specific effective scattering surface and the radiation brightness temperature. Expressions for these two parameters and their statistical characteristics have been derived, considering that the cross-section for backscattering is in this case

$$\sigma(\theta)_{P=H,V} = \gamma(\theta,\theta_s,\varphi,\varphi_s\cos\theta$$

when $\theta_s = \theta$ and $\varphi_s = \pi$ (γ - differential coefficient of scattering, θ - observation angle read from vertical direction, φ - azimuth angle, θ_s and φ_s angles defining direction of scattering, P = H, V - horizontal or vertical polarization respectively). With diffuse sky radiation ignored, the radiation brightness temperature is then $T_{rb}(\theta) = T_h - (T_h/2\pi)$ IntInt $\gamma(\theta,\theta_s,\varphi,\varphi_s)\sin\theta_s\, d\theta_s d\varphi_s$ (T_h - hydrodynamic temperature of water). According to the two-scale model, the differential scattering coefficient consists of two parts representing its Kirchhoff approximation and first-order perturbation theory approximation respectively. The latter part is an average when the ripple (small scale) is modulated by the slope of gravitational waves (large scale). Specification of the integration limits necessarily leads to inclusion of diffuse scattering in calculation of the differential scattering coefficient. The state of the sea surface will thus be determined by three parameters dependent on the wind velocity: r.m.s. ripple height, ripple intensity (Philips factor), and r.m.s. slope of large gravitational waves. The dependence of the scattering characteristics of a rough sea surface on the magnitudes of these parameters has been evaluated quantitatively by calculation of increments of the specific effective scattering surface due to change of ripple intensity alone, due to change of r.m.s. slope of gravitational waves alone, and due to combination of both. The results of this evaluation, covering the entire range of observation angles and the 3-15 m/s range of wind velocity at 19.5 m altitude, indicate that Bragg scattering takes place only within the $\theta = 25$-$85°$ sector of observation angles and that the increment of the specific effective scattering surface does not depend on the observation angle within this sector. It does, however, depend linearly on $a = 1 + \cos\theta \times \cos\theta_s - \sin\theta \times \sin\theta_s \times \cos\varphi_s$, which in turn depends on the wind velocity. Consequently, nonhomogeneous segments with anomalously changing ripple intensity under conditions of resonance scattering are equally easy to detect with horizontally and vertically polarized sounding waves within the 30-80° sector of observation angles. Nonhomogeneous segments of the sea surface formed by change of the r.m.s. slope of large gravitational waves (swelling) are much more easy to detect with horizontally polarized sounding waves than with vertically polarized ones. The results of analogous calculations for thermal detection and ranging of changes of roughness level with vertically polarized sounding waves indicate an insensitivity to change of the mean wind velocity along the sea surface within the 55-65° sector of observation angles, with 30-40 K and 8-9 K maximum changes of the radiation brightness temperature within the $\theta > 70°$ sector and the $\theta < 25°$ sector of sliding observation angles respectively, while with horizontally polarized sounding waves an increase of surface roughness raises the radiation brightness temperature at

all observation angles and an increase of the slope of gravimetric waves lowers the radiation brightness temperature at sliding observation angles. Figures 2; tables 1; references 9.

Influence of Terminator on Characteristics of Ionograms Recorded by Oblique Probing of Ionosphere over Long Path

927K0256C Nizhniy Novgorod IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 34 No 6, Jun 91 (manuscript received 15 Aug 91) pp 707-709

[Article by A.N. Baranets, T.D. Borisova, and V.A. Bubnov, Leningrad Scientific-Industrial Association "Vektor"; UDC 550.388.2]

[Abstract] Propagation of HF radio waves through the ionosphere was studied experimentally by oblique sounding of the ionosphere over a 9000 km long subauroral path in years of maximum year (1982) and minimum (1987) solar activity. The approximately 20,000 experimentally obtained ionograms were then used for correcting the Chernyshev-Vasilyev model of the F2 layer and ionograms numerically calculated according to this model under identical ionospheric conditions, for a reliable prediction of highest and lowest observable frequencies. These corrections were found to be most effective when based on ionograms recorded under quiescent geomagnetic conditions, with the entire wave propagation path either in light during the day or in darkness during the night. These corrections indicate that, for a reliable prediction of the highest observable frequency, additional sign-reversing gradients of negative ionization within the terminator region of the F2 layer must necessarily be taken into account. Figures 1; references 7.

Synthesis of Weight Distribution for Wide Nulls in Radiation Pattern of Adaptive Antenna Array

927K0256D Nizhniy Novgorod IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 34 No 6, Jun 91 (manuscript received 16 Jul 90) pp 720-724

[Article by A.B. Gershman and V.T. Yermolayev, Institute of Applied Physics, USSR Academy of Sciences; UDC 621.396.96:621.391.828]

[Abstract] Synthesis of the weight distribution in the radiation pattern of an antenna array which will ensure maximum amplification in one direction θ_0 and wide nulls in other directions $\theta_{1,2,...,M}$ is treated as a problem of conditional maximization for weight factors, wide nulls being more effective than narrow ones in minimizing the sensitivity of antenna performance characteristics to sudden change of the frequency of interference signals to be suppressed and of the angular coordinates θ of their sources. The solution to this problem, the optimum vector of weight factors, is sought in the form $W=DR$ (R - new optimizable N-dimensional complex vector, N - number of elements in antenna array, D - matrix projector onto $N\text{-}M\text{-}\Sigma_{i=1}{}^{I}K_i$ - dimensional space, K_m - dimensionless parameter characterizing width of m-th null). This formulation of the synthesis problem is applied to an adaptive antenna array operating under conditions of *a priori* indeterminacy, in which case interference suppression is based on intermittent sampling of input signals. As an example is considered an ensemble of M external narrow-band point sources of interference signals in the far field, the vector of antenna input signals at any instant of time t being expressed in the form $X(t)=\Sigma_{m=1}{}^{M} a_m(t)S(\theta_m) + V_n(t)$ (a_m - unknown complex amplitudes of mutually independent interference signals, θ_m - *a priori* unknown angular coordinates of *a priori* unknown number m of interference sources, V_n - vector of intrinsic antenna noise). Numerical evaluation of the corresponding vector of weight factors $W=[S^+(\theta_0 DS(\theta_0]^{-1/2}\ DS(\theta_0$ (+ indicating Hermitian conjugate, D - set of all matrix projectors) requires about $N^3 + N^2(M+ \Sigma_{m=1}{}^{M}K_m$ digital multiplications of complex numbers. Figures 2; references 7.

Model of the Lower Auroral Ionosphere in Calculations of the Characteristics of Radio Wave Propagation

927K0226A Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 31 No 6, Nov-Dec 91 (manuscript received 26 Feb 91, after revision 16 Apr 91) pp 1037-1041

[Article by Ye. M. Zhulina, P. V. Kishcha, A. N. Osepyan, and V. A. Vlaskov, Institute of Earth Magnetism, the Ionosphere, and Propagation of Radio Waves, USSR Academy of Sciences; UDC 550.388.2]

[Abstract] A model of electron concentration in the lower polar ionosphere is examined. This model was developed at the Polar Geophysical Institute. The characteristics of the propagation of decameter waves are calculated with this model. It is shown that when there are periods of disturbance, auroral ionization at 80-100 km has absorbing properties and significant screening properties. The model is for nonilluminated conditions. The main ionizing agent is a stream of electrons at 30 keV or higher. The parameters of the stream are defined and used to determine the rate of ion formation and the profiles of electron concentration corresponding to the observed absorption. Power law energy spectra and exponential energy spectra are examined. At and above 70 km they are similar. Differences appear below this altitude. Even during periods of low absorption, the region of auroral ionization becomes a screen over a wide range of frequencies to 10-12 MHz. This means that in some cases there is a probability of up to 40-50 percent that propagation through the F2 layer will be impossible due to screening by the auroral ionization region. In periods of greater disturbances, the region of auroral ionization may reflect frequencies up to 18 MHz. Figures 2; references 9: 6 Russian, 3 Western.

Climatic Changes of Ionospheric Absorption of Radio Waves in the Shortwave Range

927K0226B Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 31 No 6, Nov-Dec 91 (manuscript received 24 Jan 91) pp 1070-1073

[Article by G. Nestorov, D. Pancheva, and A. D. Danilov, Geophysical Institute of the Bulgarian Academy of Sciences and the Institute of Applied Geophysics, USSR State Committee of Hydrometeorology; UDC 550.388.2]

[Abstract] This article examines the change in the absorption of radio waves in a track between Allier, France and Sofia, Bulgaria during 1959-1986 using a balloon. It was found that there has been a systematic increase in this absorption. Possible causes are examined and it is shown that the most likely cause is a 5 Kelvin decrease in atmospheric temperature in the mesopause during this period. Beginning in 1959 the observatory in Sofia has continously observed the electromagnetic field of radio emissions (164 kHz) from a transmitter in Allier. This data was used to analyze absorption trends. Only May-September data were used to eliminate the effect of known absorption anomalies. Measurements were taken at noon. Absorption depends on the gradient of electron concentration. There is a systematic decrease in this quantity (by about 10 percent) at 70-80 km. This is due either to an increase in electron concentration at 70 km or a decrease at 80 km. The change at 70 km is ruled out. In the upper region of the D level there are processes in the ionization-recombination cycle which are strongly dependent on temperature. It is shown that it is reasonable for these processes, given realistic parameters, to produce a decrease in electron concentration of the required magnitude. The systematic increase in absorption can be explained by a climatic decrease in atmospheric temperature in the mesopause. This coincides with the expected cooling of the mesosphere due to an increase in the concentration of CO_2 and estimates of the temperature trend at this altitude produced from other radiophysical data. Figure 1; table 1; references 11: 8 Russian, 3 Western.

Generation of Three-Dimensional Coherent Structures During Artificial Modification of the Ionosphere

927K0226C Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 31 No 6, Nov-Dec 91 (manuscript received 16 Jul 90, after revision 18 Apr 91) pp 1057-1063

[Article by A. K. Nekrasov, O. A. Pokhotelov, and L. Stenflo, Institute of Earth Physics, USSR Academy of Sciences, and the University of Umea, Sweden; UDC 550.388.2]

[Abstract] Experiments have shown that during artificial modification of the ionosphere with strong radiation, a broad spectrum of density inhomogeneities is formed in the ionospheric plasma, and these inhomogeneities are extended along the geomagnetic field. It was found that small-scale inhomogeneities in density, with a characteristic size transverse to the geomagnetic field of an order of magnitude or less than the length of the electromagnetic pumping wave, are best stimulated when the latter are propagated along magnetic field lines. The generation of small-scale inhomogeneities is accompanied by the generation of high-frequency plasma waves running transverse the magnetic field. This article examines thermal parametric instability in the F-region of the ionosphere when it is affected by strong radio emissions. Attention is focused on low-frequency nonlinearities, which are important for inhomogeneities which are asymmetrical relative to the geomagnetic field. The possibility of establishing stable states of density disturbances in the form of coherent three-dimensional structures near the stability boundaries is examined. It is shown that it is possible to form three-dimensional coherent structures in the form of a gridwork of cells of density inhomogeneities which have a finite size along the geomagnetic field. Equations are presented to describe the nonlinear evolution of low-frequency disturbances in plasma density affected by radio waves. References 21: 9 Russian, 12 Western.

Separation of Frequency-Drifting Wideband Signals and Interference During Multichannel Detection

927K0205A Nizhniy Novgorod IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 34 No 5, May 91 (manuscript received 25 Aug 89, after completion received 26 Jun 90) pp 483-491 and insert p 1

[Article by Yu.M. Bruk, Institute of Radio Astronomy, UkSSR Academy of Sciences; UDC 621.396.62]

[Abstract] The problem of separating signals of unknown waveform, amplitude, and position in time by orthogonalization of their sum is solved for detection of frequency-drifting wideband periodic radio signals from cosmic sources such as pulsars entering a receiver together with additive local interference. The problem is solved rigorously by the Fourier method for a multichannel receiver, the signal in each k-th channel being the sum of two: useful S_k characterized by a rate of frequency drift as well as an amplitude and interference P_k characterized by an amplitude only. The number of unknown signals S as well as their waveforms and dimensionalities are limited by the number of readings N and the number of channels M only, but all S signals have different rates of frequency drift assumed to be either known or calculable from the dispersion relation and the frequencies to which their channels have been tuned. A new orthogonalization procedure involving discrete Fourier transformation is outlined which ensures filtration of one signal and minimization of all others. It is applied first to an equidistant receiver system and then to a nonequidistant one. A sensitive and simple such receiver system with minimum necessary number of channels is then synthesized in accordance

with the theory of cyclic difference sets. The procedure is shown to be applicable to three related problems; 1) interference suppression for extraction of weak delayed rather than wideband signals; 2) detection and analysis of delayed signals, 3) analysis of random processes with use of a multichannel receiver as a spectrum analyzer of random signals whose autocorrelation function depends on the frequency difference only, an example being scattering or Faraday rotation of signals during their propagation through a cosmic plasma. Figures 4; tables 1; references 7.

Statistical Model of Shearing Interferograms Obtained With Coherent Illumination of Objects Through Turbulent Atmosphere

927K0205B Nizhniy Novgorod IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 34 No 5, May 91 (manuscript received 17 Nov 89) pp 501-511 and insert p 5

[Article by A.L. Volpov and Yu.A. Zimin, Scientific-Industrial Association "Astrofizika"; UDC 621.373.8]

[Abstract] Shearing interferometry of objects in a turbulent atmosphere with coherent light is considered, coherent light like any optical signal becoming randomized by fluctuations of the refractive index so that a statistical model of shearing interferograms is needed for data processing. Two such models are constructed by the method of random electric fields, for an object located within the isoplanatic region and having a complex reflection coefficient. The first statistical model applies to such an object illuminated by a coherent light source of small transverse dimension, diameter of the light beam d smaller than the correlation length ρ_0 correlation radius of phase distortions of the optical field in a turbulent atmosphere. In accordance with the central limit theorem, the resultant noise $n(\rho)$ from a multitude of independent sources (ρ denoting the radius-vector in the plane of the exit pupil) is virtually a Gaussian and δ-correlated one. The correlation function of an interferogram $Q(\rho_1,\rho_2) = [I(\rho_1 I(\rho_2))] - [I(\rho_1)][I(\rho_2)]$ is expanded into an explicit form corresponding to $d < \rho_0$ its dependence on the difference $\rho_1 - \rho_2 = \delta\rho$ is evaluated in broad terms, whereupon an analytical expression is obtained for the probability density $w(I,\rho)$ of light intensity $I(\rho)$ in the plane of the image. The second statistical model applies to such an object illuminated by a coherent light source of large transverse dimension $d > \rho_0$, in which case fluctuations of the refractive index produce a speckle pattern with the diameter D_s of a speckle proportional to $\lambda R/d$ (R - distance from object, λ - wavelength of light) and the diameter D_0 of the entire spot proportional to $\lambda R/d$. When the dimension of the object is $L \leq \lambda R/d$, then the spatial coherence length of the object field $\lambda R/L$ is close to the light beam diameter $d > \rho_0$ and the field fluctuation scale $\varepsilon(\rho)$ is larger than the dimension of the scale change region. When the dimension of the object is $L > \lambda R/d$ or $L >> \lambda R/d$, then $\lambda R/L$ is proportional to ρ_0 and the expression for the field fluctuation scale is the same as when $L \leq \lambda R/d$. When distant objects are to be located, there never arises the practically never arises a situation that $\lambda R/\rho_0 < 1$. Figures 1; tables 1; references 8.

Quasi-Steady Thermal Radiation Field in Theory of Contact Radiothermometry

927K0205C Nizhniy Novgorod IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 34 No 5, May 91 (manuscript received 30 May 89) pp 512-518 and insert pp 4-5

[Article by A.N. Reznik, Scientific Research Institute of Radiophysics; UDC 621.371:615.47]

[Abstract] A theoretical problem of contact radiothermometry is considered: a heat-absorbing medium with an only vertically nonuniform temperature profile occupying the lower half-space emits thermal radiation into a transparent medium occupying the upper half-space, a receiver antenna of arbitrary dimensions being located in the upper half-space at an arbitrary distance from the boundary between the two media. The problem is treated as one of electrodynamics and solved as such for a quasi-steady radiation field, assuming for simplicity and without loss of generality that $E_a(r) = H_a$ in the antenna aperture. An integral expression is obtained for the power of radiation entering the antenna aperture and its dependence on the vertical temperature profile in the hot medium. This is equivalent to the expression based on ray theory in only when a quasi-steady radiation field does not influence the power readings, namely in two cases: 1) distance from antenna to surface of hot medium larger than radiation wavelength, 2) antenna aperture larger than radiation wavelength. Otherwise the ray theory needs to be corrected to account for the influence of both quasi-steady electromagnetic and thermal radiation fields, especially in practical measurement of mean temperatures and estimation of the effective probing depth. In measurement of the internal temperature of biological objects, for instance, quasi-steady fields appreciably influence the estimate of effective probing depth, which can be up to 80 percent of the skin thickness. Figures 4; references 12.

Diffraction of Electromagnetic Waves by Semi-Infinite Grid With Square Cells

927K0205D Nizhniy Novgorod IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 34 No 5, May 91 (manuscript received 9 Nov 89) pp 583-589 and insert pp 8-9 [Article by V.A. Rozov and A.A. Sochava, Leningrad Polytechnic Institute; UDC 537.874.6]

[Abstract] Diffraction of cylindrical electromagnetic waves by a semi-infinite grid with square cells is analyzed by the method of averaged boundary conditions applicable to dense grids. The wires of the grid, made of a material with finite electrical conductivity (copper or

iron), are assumed to make ideal contact at their crossings. Their orientation and the orientation of the radiation source relative to the screen edge are arbitrary, but in-phase magnetic or electric current filaments are parallel to it. The boundary conditions at the grid surface are stipulated for the sum of the incident electric field E^i and the secondary electric field E or, more precisely, for the sum of their longitudinal x-components $E^i_x + E_x$ and the sum of their transverse y-components $E^i_y + E_y$, assuming an isotropic grid structure and a uniform longitudinal distribution of the incident electric field. The two Fourier transforms of these boundary conditions with respect to the y-coordinate, together with two equations relating the current density j in the grid wires to the secondary field $E=ik\rho[A + (\text{grad} \ldots v\ A)/k^2]$ and H=curl A, yield a system of two equations which are solved by the factorization method for the current densities in the two orthogonal arrays of wires. Induction of an electric current I_E by a filament (zero y-component of incident electric field) and of a magnetic current I_M by a filament (zero x - component of incident electric field) is then considered, calculations and analysis of the results indicating that the structure of the field induced by such a grid depends strongly on the polarization of the incident wave and that surface waves appear above the grid. In this respect, therefore, a grid of wires behaves differs appreciably than a shield of solid metal. Figures 6; references 3.

Diffraction of Electromagnetic Wave by Ideally Conducting Cylinder with Nonhomogeneous Magnetic-Dielectric Coating

927K0205E Nizhniy Novgorod IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 34 No 5, May 91 (manuscript received 15 Nov 89) pp 590-594 and insert p 3

[Article by V.N. Kisel and A.I. Fedorenko, Taganrog Institute of Radio Engineering; UDC 621.371:519.64]

[Abstract] The diffraction problem for a plane electromagnetic wave incident on an ideally conducting cylinder with an arbitrary cross-section and a nonhomogeneous magnetic-dielectric coating is solved by the authors' generally applicable method of combining both surface integral and volume integral equations in a Cartesian system of coordinates with the origin on the cylinder axis, the Oz-axis. The dielectric permittivity $\varepsilon(x,y)$ and the magnetic permeability $\mu(x,y)$ of the coating are assumed to vary only around the circumference as functions of both x and y, but not lengthwise as functions of z. The electromagnetic wave is assumed to be incident normally to the cylinder generatrix and at any angle φ_0 in the (x0y) plane of cylinder cross-section. The scattered field at any point P in space outside the cylinder is calculated for the specific cases of an E-polarized incident wave $E^p = i_z E^p_z$ and an H-polarized incident wave $H^p = i_z H^p_z$. For an E-polarized incident wave are introduced the electric polarization current $I^{e,p} = i\omega(\varepsilon - \varepsilon_0)E = i_z I^{e,p}_z$ and the magnetic polarization current $I^{m,p} = i\omega(\mu - \mu_0) H = i_z I^{m,p}_z + i_y I^{m,p}_y$. For an H-polarized incident wave are introduced the electric polarization current $I^{e,p} = i\omega(\varepsilon - \varepsilon_0)E = i_x I^{e,p}_x + i_y I^{e,p}_y$ and the magnetic polarization current $I^{m,p} = i\omega(\mu - \mu_0)H = i_z I^{m,p}_z$. The integral equations are solved numerically, upon subdivision of the coating volume V into cylindrical elements having nearly square cross-sections and subsequent replacement of these with circular cylindrical elements having the same cross-sectional area. The key to solution of the two integral equations is evaluation of the integral $\text{Int}_V G(v,v')dV$ for the coating, where G is Green's function for free space, prior to their reduction to two systems of linear algebraic equation by the Krylov-Bogolyubov or any other technique. The calculations have been programmed for numerical analysis, whereupon this method was tested on comparing two-position scattering diagrams of a homogeneously coated circular metal cylinder by comparing them with those obtained by the method of eigenfunctions. For further validation were also calculated backscattering diagrams of a metal-dielectric strip and a bare metal strip, each having a finite thickness. Figures 6; references 8.

Nonsteady Processes During Interaction of Helical Electron Beam and Backward Wave in Waveguide

927K0205F Nizhniy Novgorod IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 34 No 5, May 91 (manuscript received 30 Nov 88, after revision received 14 Mar 90) pp 595-600 and insert p 12

[Article by A.Yu. Dmitriyyev, D.I. Trubetskov, and A.P. Chetverikov, Saratov State University; UDC 621.385]

[Abstract] Transient processes and buildup of oscillations in a cyclotron-resonance maser with a helical electron beam and a backward traveling wave are analyzed in the one-wave approximation, disregarding interaction of the electron beam with the forward wave at frequencies "far" off the critical one. A slightly relativistic cylindrical helical electron beam and TE waveguide with a slowly varying complex amplitude are considered in a uniform static transverse magnetic field without interaction of the beam electrons and the high-frequency components of the magnetic field. The corresponding system of two equations, standard equation of motion and equation of a backward wave induced by the electron flux, are formulated in dimensionless variables: time, longitudinal space coordinate, and normalized "radius" of electron rotation. They are first solved in accordance with the linear theory of transients for an evaluation of oscillation amplitude increments, then for a nonlinear steady state in the monochromatic approximation, and finally for a nonlinear nonsteady state leading to single-frequency steady oscillations. Figures 2; references 16.

Application of Discrete Convolution Equations for Testing the Stability of Periodic Processes in Pulse-Modulated Systems

927K0253A Moscow AVTOMATIKA I TELEMEKHANIKA in Russian No 4, Apr 92 pp 86-93

[Article by M. M. Kipnis, candidate of physical and mathematical sciences, Chelyabinsk Pedagogic State Institute; UDC 62-504.2]

[Abstract] Algorithms were developed for testing the local stability of simple periodic processes in pulse-modulated systems. The algorithms are based on the theory of stability of zero solution of discrete quasi-linear equations in convolutions, thus, the stability problem is reduced to the problem of determining the roots of some function of a complex variable. A non-exclusive T-periodic mode in a pulse-modulated system is stable, or asymptotically stable with respect to small constant perturbations if the zero solution of the discrete quasi-linear equation in convolutions exhibits a corresponding stability. From the characteristic equation $a_0+a_1/z+a_2/z^2+...=0$ with respect to the complex variable z, the stability of zero solution of a quasi-linear equation in convolution can be determined. If the characteristic equation has no roots in the region of the absolute value of $z \leq 1$, the zero solution of the equation, as well as the T-periodic mode is asymptotically stable with respect to small local perturbations, and is also stable with respect to small permanent perturbations. If the characteristic equation has roots in the region of absolute value of z greater than 1, there is no stability even with respect to small local perturbations. Figures 4, references 13: 12 Russian, 1 Western.

Stability Analysis of Nonlinear Pulse Systems With Well-Defined Pulses

927K0253B Moscow AVTOMATIKA I TELEMEKHANIKA in Russian No 4, Apr 92 pp 93-100

[Article by A. N. Churilov, candidate of physical and mathematical sciences, Leningrad Ship Building Institute; UDC 62-504.2]

[Abstract] Nonlinear systems where a pulse element is generating single-pole pulses are examined by averaging the signal at the modulator output and by applying the methods of the theory of absolute stability. This method involves examining special local quadrature interactions: the average value of the signal at the output of the modulator is associated with the value of the modulating signal at some discrete moments of time (repetition rate of these moments coincides with the pulse rate). Employment of such local interactions requires a complex mathematical treatment. This paper examines a class of systems with a well-defined pulse behavior, where the signal at the modulator output is independent of the modulating signal polarity. In particular, systems with pulse-width modulation and pulse-frequency modulation belong to this class. Using these systems as an example it was shown how the new local interactions can be reduced to traditional integral quadrature interactions within the framework of the general theory of absolute stability. References 6: (Russian)

Tabulated Low-Density Codes Which Correct the Magnitude and the Burst Error

927K0253C Moscow AVTOMATIKA I TELEMEKHANIKA in Russian No 4, Apr 92 pp 155-163

[Article by V. K. Konopelko, candidate of technical sciences, Minsk Radiotechnical Institute; UDC 519.725]

[Abstract] Tabulated codes are developed which are made up of two codes with a simple test for being even. The codes are used for correcting the magnitude and the burst error. The decoding devices of these codes are inexpensive and are based on a parallel analysis of both sides of the parity check sequence. Processing methods are also developed which make it possible to expand the range of the code's application; in particular, to employ them for protecting the memory of multidigital microcircuits from the magnitude errors, or for protecting the magnetic and optical diskettes from the burst errors. The diagonal arrangement of the coding tables where the parity check is carried out by rows and columns results in low-density codes which correct the individual magnitudes or the burst error. Depending on the diagonal's positions in the tables it is possible to construct various codes, which in some cases are intersected by known low-density codes. The speed of the magnitude correcting codes, is slower than the codes for correcting the burst error. However, the tabulated codes can be used for transmitting practically unrestricted lengths of messages; they have simple and high-speed decoding circuits, and therefore are used for development of chips with 16Mbits memory. Tables 12, references 7: 5 Russian, 2 Western.

Multiple-Input Nonparametric Detector

927K0247A Moscow RADIOTEKHNIKA in Russian No 12, Dec 91 pp 30-32

[Article by V.A. Polyakov, R.G. Tolparev; UDC 621.391.1]

[Abstract] The nonparametric detection procedure which stabilizes the false alarm probability in an unknown noise environment and obstacles to increasing the detector efficiency, particularly the correlation constrains in the statistics, are discussed. An attempt is made to produce recommendations for distributing the quantiles among the inputs of a multi-input nonparametric detector, upgrade the detector's decision statistics, and obtain a guaranteed high gain in the detector efficiency for any number of inputs and any set of random input noise quantiles. The mathematical expectation of the detection procedure based on comparison to a fixed decision statistic threshold is derived and improved decision statistics which ensure a considerable

increase in the detection efficiency known beforehand for any number of detector signal inputs and any initial set of unknown noise quantiles are proposed. These statistics are suitable for practical applications. References 5: 3 Russian, 2 Western.

Phase-Locked Loop of Low-Noise Microwave Temperature-Controlled Oscillator

927K0247B Moscow RADIOTEKHNIKA in Russian No 12, Dec 91 pp 37-40

[Article by S.L. Abramov, A.P. Kuznetsov; UDC 621.316.726]

[Abstract] The advantages of microwave oscillators with disc dielectric resonators (DDR) from leucosapphire, e.g., their low phase noise level, which makes it possible to use them as master oscillators (ZG) and the need to attain a long-term frequency instability of 10^{-9} or lower for oscillators with a temperature coefficient of frequency (TKCh) at 300K of -(45-65) x 10^{-6} 1/K are addressed and a method of meeting the latter requirement with the help of a phase-locked loop (FAPCh) in which frequency control is realized solely by means of manipulating the disc dielectric resonator temperature is proposed. The proposed variable capacitor frequency control method differs from traditional techniques in that it does not lead to a decrease in the oscillatory system *Q*-factor and ensures a considerably broader bandwidth. A block diagram of the device is cited. The PLL employs a method of tying in the microwave oscillator frequency to an active standard. The dependence of temperature fluctuations on the frequency stability is examined and the alignment process is simulated on a computer. The effect of a correcting filter and limiter on the lock-on band is plotted. The proposed method makes it possible to realize a microwave oscillation source which combines high long- and short-term frequency stability rather simply. Figures 6; references 8.

Invariance Principle and Nonlinear Signal Disturbance Prevention in Receiving and Amplifying Circuits

927K0247C Moscow RADIOTEKHNIKA in Russian No 12, Dec 91 pp 43-47

[Article by B.M. Bogdanovich (deceased); UDC 621.39.62.001.63 (075.8)]

[Abstract] The effect of nonlinear phenomena on nonlinear signal disturbance in receiving and amplifying circuits increases the urgency of developing methods of circuit synthesis which eliminate such disturbances in a known electromagnetic environment. Thus, an attempt is made to justify and develop general approaches to synthesizing a wide range of signal transmission channels with controllable nonlinear properties on the basis of the fundamental invariance principle which ensures normal performance of various materials systems in nature. Invariance as it is understood in the automatic control theory (TAU) is defined as the ability to withstand an interfering action (disturbance) and it is shown that the invariance principle is based on the physical phenomenon of disturbance equalization. A block diagram of a two-channel synthesizer with an nonlinear element (NZ) in one of the channels is cited and the related principle of parametric invariance is discussed. The use of the signal invariance principle makes it possible to synthesize paths with controlled transmitter and receiver noise and in contrast to the problem of equalizing the external disturbance, implementation of the principle is characterized by the method of forming the two-channel equalizing structure, by the constraints imposed on the input action level, and by the limit of attainable performance. Figures 3; references 5.

Effect of Interelement Phased Antenna Array Coupling on its Characteristics

927K0247D Moscow RADIOTEKHNIKA in Russian No 12, Dec 91 pp 60-63

[Article by Kh.I. Derzhani; UDC 621.396.677.494]

[Abstract] The use of remote repeater (VR) transmitters utilizing the phased antenna array (FAR) principle and its advantages over classical design methods (one transmitter for each station), e.g., high efficiency (KPD) and reliability and a smaller antenna field area in a cellular radio communication system (SZRS) are discussed and the effect of coupling among the phased array elements on the radiation pattern (DN) and output impedance of individual antennas is investigated. A block diagram of an equally spaced phased antenna array—a linear system for which the superposition conditions are met—is cited and analytical formulas are derived for calculating the individual dipole currents and fields and radiations patterns of phased antenna arrays consisting of half-wave horizontal dipoles are analyzed. The findings show that electromagnetic coupling among the array dipoles deflects the azimuth of the beam pattern's major lobe and leads to a drop in the relative major lobe maximum and, likewise, a decrease in the signal strength at the point of reception. These deviations are the most severe in the lower part of the working frequency band. Cross-coupling can be ignored if the coupling coefficient does not exceed -15 dB within the entire short wave communication band; in this case the radiated phased array power level at a 7 MHz frequency amounts to at least 90 percent of its level without coupling. Figures 3; references 4: 3 Russian, 1 Western.

Characteristics of Lamellar Radiators With Transverse-Inhomogeneous Substrate in Regular Phased Antenna Array

927K0247E Moscow RADIOTEKHNIKA in Russian No 12, Dec 91 pp 64-66

[Article by V.S. Filippov, D.V. Tatarnikov; UDC 621.396.677]

[Abstract] The use of lamellar, i.e., printed board, radiators with a transverse-inhomogeneous substrate (PNP) as low-profile elements of phased antenna arrays (FAR) in the meter and decimeter bands excited by one or several rods which are an extension of the inner conductor of coaxial wave guide transmission lines is discussed and the characteristics of printed board radiators are numerically investigated with the help of a computer software package which realizes a mathematical model of such radiators at the electrodynamic level. The dependence of the reactance and resistance of the linearly polarized radiator input impedance on the differential phase shift in the *E*-plane, the effect of the support bar orientation and position on the radiator resonance frequency and *Q*-factor, and the dependence of the input standing wave ratio in frequency and beam deflection angle are plotted. The analytical results are shown to be consistent with theoretical data obtained in a waveguide model of a periodic phased array. The findings indicate that the radiator support bar configuration has the greatest effect on the characteristics of planar printed circuit arrays with dielectric transverse-inhomogeneous substrates, particularly on the radiator matching within the array scan sector. Figures 5; references 4.

Bandwidth Properties of Microwave Thermoparametric Material Heating Units With Complex Cross Section

927K0247F Moscow RADIOTEKHNIKA in Russian No 12, Dec 91 pp 66-70

[Article by V.A. Kolomeytsev, V.V. Yakovlev; UDC 621.372.852:621.365]

[Abstract] The limited functional capabilities of rectangular and circular waveguide chambers for heat treating insulating materials with a traveling SHF (SVCh) wave and the desire to expand them by using waveguide chambers with a complex cross section, e.g., П-, H-, and T-shaped, prompted an investigation of the characteristics of working bands of such heating chambers under the conditions of varying dielectric permittivity of the material in the course of heat treatment. To this end, the characteristics of the single-mode operating condition band of microwave heating units with regular waveguides with a capacitance gap in the transverse cross section are examined as a function of the dielectric permittivity behavior within the temperature range of the heat treatment process. The study shows that in designing efficient microwave heaters with a capacitance gap, it is necessary to select the waveguide parameters on the basis of an electrodynamic analysis. To this end, a routine for numerical analysis of regular waveguide transmission lines with insulating and absorbing materials which realizes a finite element algorithm can be used. For proximate analyses and estimates, approximate formulas may be used. In practical application, a compromise solution often has to be found. Figures 2; references 13: 10 Russian, 3 Western.

Simplifying Focusing Matrix Analysis for Linear Equally Spaced Antenna Array

927K0247G Moscow RADIOTEKHNIKA in Russian No 12, Dec 91 pp 70-71

[Article by E.A. Maltsev; UDC 621.391]

[Abstract] The use of the method of coherent processing for determining the angle of arrival of wide-band signals with the help of focusing matrices is discussed and an attempts is made to decrease the volume of calculations in forming the focusing matrix for a linear equally spaced antenna array in the case where the number of focusing directions $M \leq [<]italN/2$, where N is the number of antenna array elements. The number of operations necessary for determining unitary focusing matrices is reduced due to a transition from complex computations to real in simulating the method of coherent processing. This method is expedient in numerical simulation of coherent processing if it is possible to use the linear equally spaced array and the sensor coordinates are known. It is noted that the results of numerous experiments confirm the validity of this approach. References 3: 2 Russian, 1 Western.

Gain Factors of Over-Horizon Troposcatter Line Under Antenna Motion, Scanning, and Spacing

927K0247H Moscow RADIOTEKHNIKA in Russian No 12, Dec 91 pp 71-75

[Article by Yu.P. Akulinichev; UDC 621.371]

[Abstract] A model is proposed for studying the properties of the output signals determined by the use of directional transmitting and receiving antennas which move in space, are scanned in azimuth, and are separated both spatially and in azimuth and an attempts is made to derive an explicit expression for the correlation function of these antennas, investigate its properties as a function of the transmitting and receiving antenna directivity under arbitrary spacing, and compare them to known experimental data. The random antenna gain measured at a fixed combined loss, i.e., the instantaneous radiation pattern (MDN) is defined and examined. The statistical model is shown to be theoretically and experimentally sound for over-the-horizon troposcatter paths and is suitable for statistical analysis and synthesis of tropospheric radio engineering systems for various purposes as well as for developing experimental estimates of troposcatter communication link parameters. Figures 1; references 18: 14 Russian, 4 Western.

Effect of Rain on Signal Attenuation in Space Radio Links

927K0247I Moscow RADIOTEKHNIKA in Russian No 12, Dec 91 pp 75-78

[Article by I.M. Teplyakov; UDC 538.566:621.371]

[Abstract] The shortcomings of the models, including that developed by CCIIR, for calculating the radio signal attenuation variation in the rain due to the nonuniformity of the rain intensity along the radio signal propagation path are addressed and a method is suggested for calculating the radio signal attenuation allowing for the shower component of the rain and the accompanying background drizzle whose contribution to the radio signal attenuation may be rather substantial. The method is specifically designed for use at moderate latitudes, i.e., the USSR, Canada, and the United States. It is assumed that the rain along the path consists of two components: a shower and a less heavy drizzle covering a considerably larger area. The equivalent shower zone width is derived and the equivalent path length for the shower and the dependence of the equivalent path length on the inclined path's angle of elevation are plotted. A comparison of the proposed method of calculating the equivalent path length int he rain to known experimental data attests to its accuracy. Figures 2; references 7: 2 Russian, 5 Western.

Functionally Complete Set of J-K Flip-Flops of Nontraditional Logic Types

927K0247J Moscow RADIOTEKHNIKA in Russian No 12, Dec 91 pp 88-90

[Article by S.P. Plekhanov; UDC 621.3.049.77]

[Abstract] The need to develop various types of flip-flops and the importance of understanding their logic capabilities in order to design economical digital radio electronic device (TsRU) circuits prompted a study of of the possibility of simplifying digital radio engineering device circuits by reducing the number of integrated circuits, connections between them, wire intersections, and couplings by selecting flip-flops from a functionally complete set which contains flip-flops with a nontraditional type of logic. Twenty-four logical types of flip-flops with two inputs and 10 universal types of flip-flops which, in addition to their primary function, perform the functions of D- and T-flip-flops are investigated. Flip-flop characteristic equations and truth tables and methods of producing the flip-flop D- and T-functions are summarized and block diagrams of the flip-flops are cited. The conclusion is drawn that all types of universal (J-K) flip-flops are promising and it is shown that in order to expand the functional capabilities of digital radio electronic system designs, it is expedient to incorporate into the designer's standard element library a functionally complete set of nontraditional logic flip-flops which in a number of cases have significant advantages over traditional J-K and D-V flip-flops. Figures 1; tables 3; references 6.

Plasma Circuit Breakers: Overview

927K0240A Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 37 No 1, Jan 92 pp 1-13

[Article by G.P. Mkheidze; UDC 621.316.543]

[Abstract] Various types of inductive integrators and circuit breakers and the use of the transient voltage induced by the current disconnection for generating pulsed charged particle beams are outlined and attention is focused on plasma circuit breakers (PR). Without discussing the relative advantages and shortcomings of particular circuit breaker, some issues related to the use of plasma circuit breakers are considered. In so doing, plasma circuit breakers are divided into axial and radial, depending on their configuration. Some of the early publications dedicated to examining the axial plasma diodes are reviewed and certain results of the study of radial plasma circuit breakers which have some features in common with the axial plasma circuit breakers are summarized. The circuit interruption phenomenon and current quenching discovered in the plasma diode when its current reaches a certain critical values which corresponds to the thermal current in plasma are described and the principal patterns of the process which explains the current quenching are investigated. The high-intensity electron beam generation and ion acceleration in the axial plasma diode are analyzed and current phases in a plasma circuit breaker is examined. Today's research in the field of plasma circuit breakers aimed primarily at scaling (i.e., increasing the voltage and current) the units with plasma interrupters, increasing the conduction phase duration, and shortening the current quenching time is surveyed. Figures 15; references 21: 16 Russian, 5 Western.

Theoretical Electromagnetic Wave Scattering Characteristic Analysis Methods. Steady-State Problems: Overview

927K0240B Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 37 No 1, Jan 92 pp 14-31

[Article by Yu.A. Yeremin, M.Kh. Zimnov, A.G. Kyurkchan; UDC 537.874.6]

[Abstract] The difficulties of solving the problem of theoretical analysis of the electromagnetic wave scattering characteristics in the steady-state case are discussed and the methods of solving the problem are divided into three classes: asymptotic (geometrical optics, the Leontovich-Fok theory (TKF), physical optics, and fringe waves method (MKV)); strict (method of separation of variables (MRP), Wiener-Hopf-Fok method, integral transforms method (MIP), and integral equations method (MIU)); and hybrid (stationary functional method (MSF) and Vaynshteyn's method). These methods are considered from the viewpoint of their applicability to investigating the radar characteristics of complex targets. It is stressed that the knowledge of radar scattering cross section (RPR) alone is insufficient at today's technological level and that a complete bistatic scattering pattern is needed; if the targets have their own antennas, their characteristics are also necessary. Vaynshteyn's method is regarded to be the most promising and its is speculated that new data can be obtained only by combining strict approaches with approximate

methods and by broadly utilizing computers. The overview is dedicated to the memory of I.K. Kupriyanov who inspired the authors in their effort. Figures 2; references 97: 75 Russian, 22 Western.

Refraction-Induced Attenuation During Radio Probing of Earth's Atmosphere Over Satellite-Satellite Path

927K0240C Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 37 No 1, Jan 92 pp 42-48

[Article by O.I. Yakovlev, I.A. Vilkov, V.A. Grishmanovskiy, S.D. Yeliseyev, A.I. Kucheryavenkov, V.V. Lomayeva, S.S. Matyugov, Ye.P. Molotov; UDC 621.396.96]

[Abstract] Radio probing of the atmosphere in the case where the radio wave source and receiver are located at altitudes which are much greater than the characteristic atmospheric depth and are spaced from each other by a long distance whereby the beam line passes through the entire atmosphere depth tangentially to the spherically stratified medium is considered and the results of a theoretical analysis and experimental data on the refractional attenuation of radio waves along the satellite-to-satellite earth atmosphere radio probing near the radio shadow boundary are presented. The change in the signal amplitude due to the radio wave refraction in the atmosphere is examined. The dependence of the refractional attenuation on the minimum beam propagation line altitude and the effect of *stratus* formations in the atmosphere on the refractional radio wave attenuation are plotted on the basis of theoretical and analytical data. An examination of the findings indicates that refractional radio wave attenuation at a 20 km beam propagation line altitude is distinguished by considerable constancy and virtually does not depend on the radio probing region while the signal amplitude depends significantly on the fine structure of the altitude profile of the refractive index. Figures 4; references 14: 10 Russian, 4 Western.

Prediction of Radio Wave Attenuation Statistics in Snowfalls

927K0240D Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 37 No 1, Jan 92 pp 49-54

[Article by V.N. Pozhidayev; UDC 621.371.3]

[Abstract] The effect of snow, particularly wet snow and sleet, on the attenuation of centimeter and millimeter band radio waves is discussed and a the need to develop snowfall models and methods of predicting the probability of radio wave propagation in order to assess the performance of communication systems under such conditions is stressed. A procedure based on published data and certain experimental results obtained around Moscow is proposed. The values of the proportionality coefficient m in the dependence of the radio wave damping factor on the snowfall rate which depends only on the radio wave frequency and type of snow (moisture content) are summarized and the frequency dependence of the proportionality factor m is plotted. The experimental and theoretical values of the snow attenuation probability distribution are compared and the normalized snowflake size distribution is plotted. The experimental and theoretical probability distributions for a space path in Dubna during the winter are compared. An analysis of the attenuation probability distribution prediction procedure indicates that the values it produces are close to experimental data and it can therefore be used for estimates. It is shown that there is little likelihood that the accuracy of analytical techniques can be improved until sufficient experimental data are accumulated on the probabilistic attenuation distributions in snowfalls. Figures 4; tables 1; references 12: 9 Russian, 3 Western.

On One Method of Expanding Antenna Bandwidth

927K0240E Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 37 No 1, Jan 92 pp 55-64

[Article by B.M. Levin, A.F. Yakovlev; UDC 621.396.67.01]

[Abstract] The shortcomings of vertical linear dipoles (e.g., whips) for mobile short wave communications and their advantages, particularly the fact that by manipulating the antenna height one can improve its characteristics, are discussed and an antenna in which the length of the radiating section can be changed without changing its geometrical dimensions is investigated. The antenna designs are considered and an equivalent asymmetric line diagram is cited. The proposed two-stage antenna consists of two dipoles located one above the other: the upper one is linear and the lower one is folded. The electromotive forces driving the antenna are applied to both wires of the folded dipole, so by manipulating the EMF one can change the height of the antenna's radiating section within a broad frequency range and thus ensure a radiation pattern clinging to the ground. The current distribution in the antenna with a coaxial wire and reactive load in the cophased and antiphase conditions and the beam pattern of the antenna in the cophased and antiphase conditions and the amplitude of the current distribution along the antenna wires are plotted. The electrical parameters are calculated using the moment method and the unbalanced line method. An analysis of the findings indicates that the proposed principle of changing the electrical height of the radiator without altering its geometrical dimensions realized in the two-level antenna is workable but calls for an additional study in order to implement it in real systems. Figures 5; references 4.

Effect of Earth's Atmosphere on Spatial Resolution of Space-Based Synthetic Aperture Radar

927K0240F Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 37 No 1, Jan 92 pp 90-95

[Article by N.V. Kretov, T.Ye. Ryzhkina, L.V. Fedorova; UDC 621.396.67.01]

[Abstract] The effect of the terrestrial atmosphere, including the troposphere and ionosphere, on the signals of space-based synthetic aperture radar (RSA) and the effect of the refractive index fluctuations on the signal phase fluctuations along the synthetic antenna path which limits the aperture length and, as a consequence, its range and azimuth resolution, are discussed and the traditional approach based on the theory of radio wave propagation in turbulent media is extended to the case of terrestrial atmosphere. The structural function which describes the phase fluctuations along the aperture is derived and the correlations between the radar resolution and the synthetic aperture radar characteristics and the wavelength and atmospheric parameters are established. The dependence of the minimum range and azimuth resolution on the wavelength is plotted and it is shown that regardless of the SAR altitude, the minimum azimuth resolution of 15-20 cm is attained at a 3-5 cm wavelength while the minimum range resolution increases monotonically with the wavelength from several centimeters to several meters. The SAR range resolution is limited due to an increase in the convolution duration of the wide-band outgoing and echo signals due to dispersion distortions in the ionospheric plasma. To ensure the minimum spatial resolution, it is necessary to have an aperture which exceeds those ensuring the above figures without phase fluctuations by a factor of 1.6. Figures 1; tables 1; references 5: 4 Russian, 1 Western.

Forms of Minimal Fast Fourier Transform Algorithm

927K0240G Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 37 No 1, Jan 92 pp 117-125

[Article by Yu.A. Sudakov; UDC 519.688:517.518.45]

[Abstract] Minimal fast Fourier transforms are represented in the form of graphs and matrices and it is shown that the principal forms of the minimal fast Fourier transform (MBPF) are close to classical forms: *MST*, *MSF*, *MRT*, and *MRF* with a symmetric and quasiregular structure. In contrast to the classical form, however, the permutational matrix is not symmetric, as a result of which various permutations are possible for different routines, yet the problem is solved easily by substituting the roles of indices, i.e., writing:reading. A simple algorithm is proposed for determining the reading indices. All minimal fast Fourier transform algorithms are simulated on an SM1420 computer and partially on an SM1700 computer whereby the convolution problem is solved. The computer experiments shows that it is possible to attain an 11 percent error gain and an up to 30 percent computer speed gain. The results may facilitate implementation of the proposed algorithms. Figures 5; references 4.

Electron Beam Acceleration as Means of Frequency Conversion in Klystron-Type Devices

927K0240H Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 37 No 1, Jan 92 pp 126-132

[Article by A.V. Smorgonskiy; UDC 621.385.623.4]

[Abstract] A method of retuning the frequency in a klystron-type device based on manipulating the clustering electron bunch velocity by means of applying an additional filed to the beam while maintaining the distance between the bunches is considered and a klystron-type device consisting of an electron gun operating in the pulsed mode, a buncher which modulates the current in velocity and frequency, and a catcher tuned to a certain frequency is examined. A block diagram of the klystron-type device is cited and the space-time motion diagram of electrons undisturbed by the RF field is plotted. It is shown that an additional pulsed electric field applied to the electron beam makes it possible to translate the modulation frequency up or down the spectrum, obtain narrow-band output signals, and produce signals with an intrapulse frequency modulation. An explicit law of the electron transit time variation is derived on the basis of the relationship between the modulation frequency, transit time, and output frequency. The author is grateful to V.B. Gildenburg for constructive discussions. Figures 3; references 11.

On Issue of Model of Resonance Microwave Radio Wave Scattering by Sea Surface

927K0240I Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 37 No 1, Jan 92 pp 169-172

[Article by I.Ye. Ushakov; UDC 621.371.332.4]

[Abstract] The development of remote sensing methods prompted interest in studying the patterns of radio wave scattering by the sea surface and attempts to simulate resonance scattering of microwave frequency signals by the sea surface. The model is considered allowing for resonance scattering characteristic, i.e., the dependence of the backscattering intensity on the ratio of the spatial characteristics of the irradiated statistically rough surface and the wavelength, and the change in the surface ordinate variance fluctuations. Resonance scattering characteristics calculated at a 10, 45, and 60° grazing angle and the dependence of the center frequency shift and spectrum expansion on the wavelength at a 3, 45, and 60° grazing angle are plotted. The findings confirm the validity of considering the wave model of wave generation in the direction away from the sea surface

allowing for the effect of the resonance scattering characteristic. It is shown that the proposed approach may also be used in the case of bistatic radar probing and anisotropic surface waves. Figures 2; references 10.

Computation Realization of Cyclic Autocorrelation Radio Signal Functions by Acoustooptic Delay and Multiplication Device

927K0240J Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 37 No 1, Jan 92 pp 173-176

[Article by V.S. Kulakov, Yu.I. Nikitin, Ye.Yu. Nikiforova, L.N. Preslenev; UDC 621.317]

[Abstract] The shortcomings of existing methods of signal classification by the type of pulse modulation prompted a search for classification algorithms employing the theory of cyclic steady-state processes which may be used successfully in processing quasicontinuous phase-shift keyed signals. Either a set of cyclic autocorrelation functions or the cyclical signal spectrum serve as the basis for classification in this case. Spectrograms of the output signal of an acoustooptic delay and multiplication device proposed for implementing the function analysis for a pseudorandom 2PSK signal and the theoretically and experimentally measured cyclic autocorrelation functions are plotted. The experiment confirms the possibility of using the acoustooptic device for producing the cyclic autocorrelation functions and indicates that the signal processing bandwidth limitation (due to the finite modulator bandwidth, i.e., the introduction of the "window" function in terms of spectral analysis) calls for examining the issue of the consistency of cyclic autocorrelation function estimates. Figures 2; references 9: 5 Russian, 4 Western.

Diffraction Slit Antennas (Survey of the Theory and Methods of Calculation)

927K0237A Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 36 No 12, Dec 91 (manuscript received 5 Jun 91) pp 2257-2280

[Article by Ya. N. Feld and L. S. Benenson; UDC 621.396.677]

[Abstract] Beginning with a historical overview, this article describes the foundations of the general theory of diffraction slit antennas, including slit antennas with axial symmetry, antennas with asymmetrical narrow slits, and emitting slits. The application of the method of directed magnetomotive force to the design of waveguide slit antennas is described. Waveguide multi-slit antennas are discussed. References 60: 48 Russian 12 Western.

Toward a Theory of Molecular Absorption of Centimeter and Millimeter Radio Waves in Oxygen

927K0237B Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 36 No 12, Dec 91 (manuscript received 31 May 89) pp 2281-2290

[Article by S. V. Titov and Yu. P. Kalmykov; UDC 539.287:621.371.166]

[Abstract] An analog of the J-diffusion method developed here is applied to the case of magnetic dipole absorption in oxygen and used to describe the spin-rotation absorption spectrum of molecular oxygen. The case where the halfwidth of the absorption line transition i <->j depends on the states i, j is discussed. A good correlation of theoretical and experimental data is obtained for the absorption of microwave radiation at pressures from 0.1 to about 60 atm. A comparison with other models is provided. This model is theoretically preferable to other models because the latter do not satisfy a high-frequency rule presented in this article. The results can be used to solve practical problems where it is necessary to predict the absorption spectra of oxygen in w wide range of frequencies, pressures, and temperatures. Figures 4; references 18: 4 Russian 14 Western.

Field of a Linear Stationary Noise Signal Emitter

927K0237C Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 36 No 12, Dec 91 (manuscript received 30 Jul 90) pp 2371-2378

[Article by O. N. Maslov and S. V. Tsarkov; UDC 621.396.67]

[Abstract] A general solution to a system of Maxwell's equations is used in the analysis of the radiation of nonsinusoidal waves. The approach is used here to examine the radiation of a linear conductor with a signal of arbitrary shape (i.e., a conical spiral) in the form of a stationary random process with an equilibrium energy spectrum given in a limited band of frequencies. The solution requires a definition of the angular characteristics of the noise dispersion, which corresponds to the orthogonal component of the vector of the electric field strength of a linear radiator transmitting at a bandwidth of frequencies occupied by the noise signal. First, the results make it possible to evaluate the effectiveness of the emission of signals of this type by antennas of various designs. Second, they are used as the basis for calculating the noise dispersion in the bandwidth of the receiver, which is an important step in solving the problem of electromagnetic compatibility of radio electronic devices. Figures 4; references 5 (Russian).

Passive Fiber Optic Displacement Sensor With a Magnetically-Soft Amorphous Alloy Microresonator

927K0237D Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 36 No 12, Dec 91 (manuscript received 11 Feb 91) pp 2385-2390

[Article by S. M. Kozel, V. N. Listvin, and A. V. Churenkov; UDC 681.7.068]

[Abstract] This article proposes a fiber optic displacement sensor based on a magnetically soft amorphous alloy microresonator. Mechanical vibrations in the microresonator are excited by photothermically modulated laser radiation, and are recorded with a fiber optic Fabry-Perot interferometer. The use of fiber lightguides to transmit light makes the sensor completely passive, and the frequency representation of the output signal makes it possible to minimize the effect of random attenuations in the fiber. There is a theoretical examination of the mechanism of magnetic elasticity and magnetic force effects, which lead to a change in the frequency of intrinsic vibrations of the microresonator for small displacements of a constant magnet. The high sensitivity of the sensor makes it promising for passive measurement of force, acceleration, pressure, and temperature. Figures 4; references 9: 1 Russian 8 Western.

Analytic Optimization of Excitation of an Antenna Array in Detection of Radar Signals on a Background of Passive Noise

927K0237E Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 36 No 12, Dec 91 (manuscript received 4 Jan 91) pp 2412-2415

[Article by A. D. Pluzhnikov; UDC 621.391.82]

[Abstract] When continuous or quasi-continuous radiation is used to increase the effectiveness of temporal (Doppler) selection of moving targets, near intense passive noise is present at the smae time as weak useful signals from the furthest target. In this case it is possible to use effective spatial processing of signals on the background of passive noise even when it is coming from one direction. This processing is done at an increased scanning rate. Despite the worsening in the selection of the moving target due to the faster scan, the space-time processing overall is very effective at some optimal scanning rate. The gain in the signal to noise ratio at this faster scan rate is 37 dB. Figures 2; references 7 (Russian).

Optimal Control of a Moving Object Evading Searchers

927K0227A Moscow TEKHNICHESKAYA KIBERNETIKA in Russian No 1, Jan-Feb 92 (manuscript received 26 Jun 90, after revision 15 Mar 91) pp 42-48

[Article by V. F. Kopeykin, State Scientific Research Institute of AS (expansion not given), Moscow; UDC 518.9]

[Abstract] The problem of finding an optimal trajectory for a moving object evading detection by a group of searchers of one type is examined. An analytical solution of this variation problem is obtained with mobile boundaries in a broad class of curves. This differs from the known solution of the problem in a narrower class, the class of straight lines. The required number of searchers to guarantee detection of the object taking an optimal evasive trajectory is defined. For the case of a limited amount of searchers, the region of guaranteed nonevasion (or evasion) of an object moving along an optimal evasion trajectory is defined. The conditions are that the searchers know the object is in a given region, and the object has necessary information about the searchers. The searchers "comb" the area in a straight line formation. The object is considered detected when it intersects the search line. The object makes the most advantageous evasive maneuver. The optimal trajectory is found to be straight lines at an angle to the search line. The required number of searchers is unambiguously determined from the length of the search line. Figures 2; references 9 (Russian).

Optimal Control of the Separation of Ships Considering Their Dynamic Capabilities

927K0227B Moscow TEKHNICHESKAYA KIBERNETIKA in Russian No 1, Jan-Feb 92 (manuscript received 12 Apr 91, after revision 17 Jul 91) pp 49-56

[Article by A. I. Kulikov, V. D. Kuznetsov Siberian Physicotechnical Institute at Tomsk State University; UDC 656.61.052:681.5]

[Abstract] Current automated ship navigation systems do not guarantee collision prevention, because they solve the separation problem using straight line trajectories and may not consider the case where a ship leaves its trajectory due to circulation. This article develops an algorithm to construct optimal trajectories for ship separation in bodies of water of limited size when there is a great density of movement. This trajectory is constructed using models of a ship moving way from another ship. The models used here consider the ship's dynamic capabilities and characteristics and recommend to the navigator an optimal solution (at least locally, if it exists) for a selected time interval. The use of efficient computing models makes it possible to implement the algorithm in current on-board real-time computers. Zoutendijk's method is used. Although it is cumbersome, it permits one to analytically avoid massive mathematical constructions, thus fostering efficient computing. The application of the algorithm in practical examples shows its rapid convergence (3-8 iterations). Figure 1; references 8: 6 Russian 2 Western.

Approximate Solution of the Reverse Problem of Controlling a Linear Object

927K0227C Moscow TEKHNICHESKAYA KIBERNETIKA in Russian No, Jan-Feb 92 (manuscript received 24 Jul 90, after revision 4 Jan 91) pp 57-75

[Article by D. M. Gorinevskiy, Institute for Problems in the Transmission of Information, USSR Academy of Sciences, Moscow; UDC 62-50]

[Abstract] This article examines the construction of a program to control a linear stationary object with a given convolution integral. The limitation and sensitivity of the approximate solution of the reverse control problem is studied, and the quadratic (regularizing) functional is minimized. The problem of moving the object into a new stationary state is studied given a desired constant output signal. To solve the problem in a minimized functional, there is a penalty for deviation of the output signal from the desired stationary value. The sensitivity of the control laws to a change in object parameters is studied. In general the object is given by a convolution integral, so most of the results also hold true for objects with distributed parameters. The first section contains known results and gives an approximate solution to the reverse problem of control of a linear object in a finite time interval. Control is based on minimization of the quadratic functional. Section two discusses the approximate numerical construction of control, limited control, and sensitivity. The third section studies the movement of the object to a new state. The fourth section discusses quadratically-optimal control. The fifth section presents the examples of the control of the heating of a rod and control of the change of position of a three-mass oscillating system which models an elastic section of a manipulator. Figures 3; references 14: 10 Russian 4 Western.

Optimal Control of the Motion of an Object in Four-Dimensional Space

927K0227D Moscow TEKHNICHESKAYA KIBERNETIKA in Russian No 1 Jan-Feb 92 (manuscript received 20 Oct 90, after revision 30 May 91) pp 76-82

[Article by D. S. Tlmofeyev, Moscow; UDC 62-50]

[Abstract] The problem of optimal control of the motion of an object is examined in four-dimensional space, which is obtained by mathematical transformation of a three-dimensional space on the basis of a quaternion representation of the angular motion of a solid body. The minimized functional is a quadratic functional of generalized work. A comparative analysis of algorithms of optimal control is presented here. The algorithms are obtained for a typical three-dimensional space and for four-dimensional space. One of the implementations of numerical modeling illustrates the capability of the synthesized algorithm for the control of spatial movement of the object. Figure 1; references 6 (Russian).

Identification of the Coefficients of Excitability of Two-Dimensional Vibrations of Large Space Constructions With a Limited Complement of Measurement Devices

927K0227E Moscow TEKHNICHESKAYA KIBERNETIKA in Russian No 1, Jan-Feb 92 (manuscript received 20 Mar 90, after revision 24 May 91) pp 113-121

[Article by V. Yu.Rutkovskiy and V. M. Sukhanov, Institute of Control Problems, USSR Academy of Sciences, Moscow; UDC 629.78]

[Abstract] This article poses the problem of identifying the parameters of deformable spacecraft which, due to their large size, low construction rigidity, and complex configuration, cannot be defined with a sufficient degree of accuracy from the results of dynamic testing of the construction in Earth conditions. An approach is developed here for the definition of parameters of large space structures in space conditions. This approach is based on a new modal-physical means of describing the dynamics of the angular motion of this class of spacecraft. Based on the introduction of two sequentially-conjugated integrals of free and stimulated movement of an elastic satellite and measurements of the angles and angular velocities at defined points of these integrals, a closed system of algebraic equations is formed which is linear relative to the vector of unknown coefficient of excitability of elastic modes. The problem of identifying all parameters of a modal-physical model of a deformable satellite is formulated on the basis of a solution of a closed system of nonlinear equations. During modeling it was assumed that there would be nonideal sensor output, measurement noise and inaccuracy in assignment of the spectral matrix of the object. It was found that the identification accuracy depends noticeably on the estimation of the vector of the initial state of the spacecraft. A significant contribution to error in identification of the matrix of the excitation coefficient is made by inaccuracy in giving the values of the eigenfrequency of the object. For example, for a 10 percent error in assigning these parameters, the average identification error may reach 17 percent. References 4 (Russian).

Diffraction of Surface Waves by Grating of Metal Rods and Performance Analysis of Dielectric Leaky-Wave Antenna

927K0200A Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 36 No 10, Oct 91 (manuscript received 28 Feb 91) pp 1902-1909

[Article by V.I. Kalinichev and Yu.V. Kuranov; UDC 621.396.67]

[Abstract] A method of analyzing the diffraction of a surface wave by a grating of thin metal vibrator rods is proposed which takes into account the edge effect. The problem is formulated for a finite number N of parallel identical cylindrical metal rods, with a radius r much smaller than the wavelength λ of incident radiation, forming a plane array in air with a space period s at a uniform distance d from a dielectric plate of uniform thickness 2a mounted on a metal base. The problem is solved for a surface H-wave whose $E_y e^{i\omega t}$-component has an amplitude $E_{y0}(x,z) = e^{-\gamma z}\sin(x\beta)/\sin(a\beta)$ in the dielectric material (ε- relative permittivity) and

$$E_{y0}(x,z) = e^{-\gamma z}\sin(2a\beta)e^{i\alpha(x-2ai)}/\sin(a\beta)$$

in air (origin of coordinates on plate-base interface, x-axis normal to dielectric plate and diffraction grating in air, y-axis on plate-base interface parallel to axes of grating rods, z-axis on plate-base interface parallel to line perpendicular to axes of grating rods, $\alpha = (\gamma^2 - k^2)^{1/2}$

external transverse wave number,

$$\beta = (\varepsilon k^2 - \gamma^2)^{1/2}$$

internal transverse wave number, $\gamma = kU$ longitudinal wave number, $k = 2\pi/\lambda$ wave number in free space, U-phase slowdown coefficient which satisfies the dispersion relation $\alpha \times \sin(2a\beta) + \beta \times \cos(2a\beta) = 0$. The system of N integral equations for the distribution functions of surface current density on each rod is, in the approximation of thin rods and zeroth-order harmonics only, readily reduced to an Nth-order system of linear algebraic equations for the complex amplitudes of those harmonics in the rods. This can also be done, in the approximation of infinitesimally thin rods, a with the aid of Green's function for the electric potential of a cophasal array of electric current filaments simulating the rods. On this basis are calculated the currents induced in this grating and its radiation pattern. The model is then applied to a numerical performance analysis of a dielectric antenna for $\lambda = 5$ mm and $f = 60$ GHz leaky waves, a $2a = 1$ mm thick dielectric plate made of Al_2O_3 ceramics ($\varepsilon = 9.8$) and grating rods with an $r = 0.02\lambda$ radius spaced $s = 0.3657\lambda$ apart on the surface ($d = 0$) of the the plate so that $\gamma = 2.461k$ and the phase shift from one rod to the next is $s\gamma = 1.8\pi$. The thus evaluated dependence of the diffraction characteristics of such a grating on the number of rods indicates that, as their number is increased and the edge effect becomes correspondingly less significant, the magnitude of the reflection coefficient increases toward some maximum and the magnitude of the transmission coefficient decreases to zero. Even with a large number of grating rods ($N = 51$), however, the edge effect continues influencing the antenna emission power. Figures 4; references 10.

Method of Approximating Angle Dependence of Phase Velocity

927K0200B Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 33 No 10, Oct 91 (manuscript received 5 Mar 90) pp 1910-1915

[Article by S.P. Kuzyakin and V.V. Shtykov; UDC 537.874.01.534]

[Abstract] A problem pertaining to propagation of waves through anisotropic media is considered, namely dependence of their phase velocity or of its inverse on the direction of their propagation and description of this dependence in some analytical form. An example of such a problem is a plane wave incident on the boundary between two anisotropic media, where it splits into one passing upon refraction into the second medium and one returning upon reflection into the first medium. It is proposed to approximate the dependence of its phase velocity in the second medium on the refraction angle directly in a Cartesian system of coordinates, thus avoiding transformation from its usual description in polar coordinates, with the aid of an approximating function which represents a closed plane curve and whose values have been tabulated. As approximating function is selected an implicit power polynomial $F(x,y) = \Sigma_{i=0}^{I}\Sigma_{j=0}^{J} C_{ij}x^iy^j = 0$, the simplest one them being $x^2 + y^2 - R^2 = 0$. The problem is to determine the unknown coefficients C_{ij}, the procedure being analogous to that used for determining those of a polynomial passing through values of a tabulated function: 1) stipulate numbers I and J; 2) discard, if possible, superfluous terms of this polynomial when the approximating function is a symmetric one (j=i); 3) construct a system of N linear equations for coefficients C_{ij} , their number N being equal to the number of terms in the polynomial; 4) calculate coefficients C_{ij} in the first approximation. For a closer approximation, solve the optimization problem for the number N of points by the min-max method. The procedure is demonstrated on a surface acoustic wave refracted by a bare Y-cut of $LiNbO_3$ crystal and by a metallized one. The refraction surface is approximated by a polynomial function containing, by virtue of symmetry, only even terms. The absolute error of this approximation is not larger than the error of determining the phase velocity of a surface wave in given directions experimentally or by numerical solution of the problem for each direction. An associated subproblem may be to determine the unknown component of the wave vector of a plane wave from its known other component, a problem of refraction solvable in the approximation of geometrical optics or a problem of diffraction solvable by the angular spectrum method. One drawback of the proposed procedure is that an even-powers approximating polynomial function is an ambivalent one, which makes it difficult to select the initial approximation points and which may yield lateral branches along with the principal one. The algorithm of determining the unknown C_{ij} coefficients must, therefore, be refined so as to not only improve the accuracy of approximation and the economy of computation but also eliminate ambiguity in the real x,y domain. Figures 5; references 8.

Polarization Processes in Optical Fibers and Noise in Fiber-Optic Tachometers

927K0200C Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 36 No 10, Oct 91 (manuscript received 20 Jul 90) pp 1945-1952

[Article by Yu.D. Bespyatov and M.Ya. Yakovlev; UDC 621.372.8]

[Abstract] The transient processes of interpolarization in a long birefringent optical fiber are analyzed on the basis of two coupled first-order partial differential equations describing propagation of light through two polarization channels in such a fiber, assuming a linear coefficient of interpolarization coupling. This system of equations is solved by the method of successive approximations and with the aid of two successive Laplace-Carson transformations, the first one with respect to time t and the second one with respect to the space coordinate x. It is solved for both linearly polarized and circularly polarized light entering the fiber. On this basis is then analyzed and evaluated polarization noise in a fiber-optic heterodyne tachometer consisting of a frequency-modulated light source at the entrance to the birefringent fiber, a light splitter (1) separating the two channels, two polarizers, two photodetectors, and four more light splitters. The two polarizers, each behind a light splitter (2,3)

at the end of each channel diverting light to a photodetector, are in unequal arms of a Mach-Zehnder interferometer formed by two light splitters (4,5). These two are on their output side joined pairwise by unequally long fibers of two Sagnac interferometers. The interpolarization coupling coefficient is assumed to be nonuniform, tapering exponentially along both channels at the same rate but remaining larger in one channel than in the other, so that transient processes in the fiber are not symmetric. Into account are taken the longitudinal temperature gradient due to local heating and the temperature dependence of both refractive indexes. Numerical estimates indicate that the polarization noise is much less influenced by the temperature gradient than by local variation of the interpolarization coupling coefficient. Figures 2; references 3.

Refraction of Surface Magnetostatic Waves by Ferrite/Ferrite-Dielectric-Metal Interface

927K0200D Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 36 No 10, Oct 91 (manuscript received 22 Jan 91) pp 1959-1967

[Article by A.V. Vashkovskiy, V.I. Zubkov, E.G. Lokk, and V.I. Shcheglov; UDC 537.622.2]

[Abstract] A theoretical and experimental study of refraction of surface magnetostatic waves by an interface between a plain ferrite film and a structure built on it was made, the structure consisting of a metal strip parallel to the ferrite film and separated from it by an air gap. The theoretical analysis is based on the law of refraction which derives from the usual electrodynamic boundary conditions of equal tangential wave vector components on both sides of the interface, as boundary between the two media being regarded the projection of a strip edge onto the film. The experiment was performed with a 16 μm thick YIG:Ga film 60 mm in diameter with a saturation magnetization $4\omega M_0$= 840 G and $2\Delta H$= 0.6 Oe wide resonance line. The metal strip was 5 μm copper film, 6 mm wide and 40 mm long, on a Polycor substrate. Both transmitter and receiver antennas were 3.7 mm long straight segments of gilded tungsten wires 12 μm. The experiment was performed with 2.52-2.67 GHz surface magnetostatic waves, the angle of incidence being varied over the 0-60° range. The width of the air gap was varied over the 25-600 μm range. The measurements have yielded data for evaluating the dependence of the refraction angle on these three variables. The results may be useful for the design of various SMSW devices such as a frequency-division filter with a maximum number of minimum-bandwidth channels. A channel switch is also realizable, based on change of gap width with the amount of change depending on the frequency of the surface magnetostatic wave. Figures 4; references 8.

Theoretical-Numerical Rapid Multiplication Algorithm for Digital Processing Devices

927K0228A Moscow IZMERITELNAYA TEKHNIKA in Russian No 1, Jan 92 pp 10-12

[Article by A. S. Gorshkov and V. F. Kravchenko; UDC 681.3.06:621.391.2]

[Abstract] Digital processing of binary information involves a large number of multiplications. This is especially true for digital filters, fast Fourier transforms, and other important algorithms. There are a large number of fast multiplication methods based on standard shift-addition operations. The fastest hardware multipliers are matrix and tree multipliers. This article presents a new and improved algorithm for binary multiplication which unites the use of shift addition, the use of logarithms and exponents (tables of logarithms and exponents are used to replace multiplication with addition) and residue arithmetic. It is based on a theorem on original roots (primitive elements) of a Gaussian field. The procedure is outlined and examples given. The algorithm and architecture of fast multiplication are similar to the execution of fast convolution based on a fast Fourier transform. Two device schematics are given. Figures 2; table 1; references 4 (Russian).

Computation Algorithm and Architecture of a High-Speed Fast Fourier Transform Processor

927K0228B Moscow IZMERITELNAYA TEKHNIKA in Russian No 1, Jan 92 pp 12-15

[Article by V. F. Kravchenko and A. S. Gorshkov; UDC 621.391.837]

[Abstract] There are various methods of calculating a fast Fourier transform. The drawbacks of other methods are outlined. A radical method of overcoming the traditional drawbacks of fast Fourier transform algorithms is a switch to a base which allows a simpler and faster hardware implementation of base operations. The newly synthesized fast Fourier transform algorithm combines the advantages of a number of digital signal processing methods, that is, a number of versions of the fast Fourier transform. A high degree of paralleling is achieved. Figures 2; table 1; references 13: 9 Russian 4 Western.

Small Length Standards for Industrial Monitoring of Integrated Circuits

927K0228C Moscow IZMERITELNAYA TEKHNIKA in Russian No 1, Jan 92 pp 21-22

[Article by N. L. Istomina, O. V. Sychev, F. N. Basmanov, and L. N. Nevzorova; UDC 621.371.39:621.317.7]

[Abstract] Close tolerances are required in the manufacture of integrated circuits and other microelectronic products. All monitoring operations are preceded by calibration of the monitoring and measurement equipment with a standard. The variety of physical methods of measuring linear size yields a variety of standards. Elements of the topology of integrated circuits may be measured with optical microscopy, raster electron microscopy, or raster optical microscopy. A key problem is determination of the exact correlation between the threshold parameters of the image of the element and the location of their true edge. Standards are needed to unambiguously interpret images of micron and submicron objects. The edge problem arises when linear size is decreased to a value comparable with the wavelength of the laser radiation used in optical microscopy. Since elements are not typically ideal rectilinear or trapezoidal structures, these deviations must be carefully considered. Acceptable levels of error are discussed. The standards of various countries are enumerated. Procedures for verifying the accuracy of standards and determining their level of indeterminacy are outlined. The authors have created a model standard for small lengths in the micron and submicron range. They discuss the design of the standard, its construction, and testing. It is concluded that a standard for microelectronics should be created with elements with vertical walls from materials which enable measurement using optical microscopy and raster electron microscopy. Methods must be developed to measure topology elements with slopes of an arbitrary angle. Figures 2; references 7: 2 Russian 5 Western.

System To Record, Evaluate and Image the Results of Testing Software in a CAD System for the Aircraft Piloting and Navigation Systems

927K0228D Moscow IZMERITELNAYA TEKHNIKA in Russian No 1, Jan 92 pp 30-31

[Article by K. A. Garin and V. V. Mechtayev; UDC 681.3.01:65.015.13.011.56:629.7.066]

[Abstract] A testing system has been created which partially simulates in-situ conditions for the automated testing of complex software systems, in particular, software for the piloting and navigation systems of aircraft. This testing system is part of a CAD system, and it improves the quality of software and increases the confidence level when processing large quantities of data. The testing system has three subsystems for recording, imaging, and evaluating results. Each subsystem is described in detail. An equation is derived for the target efficiency. Target efficiency and error analysis are addressed. Figure 1; references 5 (Russian).

Means of Electronically Processing a Signal in Phase Fiber Optic Sensors

927K0228E Moscow IZMERITELNAYA TEKHNIKA in Russian No 1, Jan 92 pp 31-33

[Article by N. D. Kozlova; UDC 681.7.068.087.92]

[Abstract] The effect of various external factors on the sensitivity of various types of fiber lightguides is discussed. In a phase sensor, these factors may affect the phase of a light wave passing through a sensitive element. Phase change is due either to refraction or double refraction. Phase sensors may have internal or external modulation. A phase-modulated signal should be transformed before it is recorded. Various means of transformation are discussed, including interferometers and a polarimetric scheme. Isolation of the phase component modulated by the external factor and means of compensating for it are discussed. The advantages and drawbacks of the methods are examined. The areas of application of various types of interferometers are outlined. Figures 2; table 1; references 7 (Western).

Multiplexed Systems of Fiber Optic Sensors of Physical Quantities

927K0228F Moscow IZMERITELNAYA TEKHNIKA in Russian No 1, Jan 92 pp 40-42

[Article by D. I. Mirovitskiy; UDC 681.7.068.087.92]

[Abstract] A multiplexed system of fiber optic sensors is a set of local fiber optic sensors united by a common fiber lightguide. Each sensor can be addressed. Such systems unite a large number of sensors, increase the efficiency of expensive signal processing, and decrease the number of sources and receivers of radiation, the length of connecting fiber lightguides, and the cost of telemetry systems. This type of sensor can be introduced directly into composite construction materials, forming "smart laminates." The sensing optical pulse (or continous modulated beam) passes through all local fiber optic sensors connected in series or parallel, and demultiplexing is done at the output with subsequent detection of the signal (time, frequency, spectral, or coherence length signal) from the selected sensor. It is simplest to multiplex amplitude sensors. A schematic is provided. Frequency multiplexing is described, and an original schematic for frequency demultiplexing is presented. In spectral multiplexing, each sensor works at its own optical frequency. A schematic is provided. Phase and frequency fiber optic sensors are described in detail and illustrated. Coherent multiplexing is also addressed. A practical topology for a system of multiplexed fiber optic sensors is described for use in an interferometer. The types of multiplexing which can be used for psuedoheterodyne, active homodyne, and heterodyne detectors are outlined. Figures 2; table 1; references 17: 4 Russian 13 Western.

Determination of Allowable Operating Currents in Busbars With Bolted Joints

927K0105D Moscow ELEKTRICHESTVO in Russian No 6, Jun 91 (manuscript received 11 Jun 90) pp 69-73

[Article by A.P. Dolin, candidate of technical sciences, A I. Plis, candidate of technical sciences, and S.A. Bessonov, engineer, Moscow Institute of Power Engineering; UDC 621.316.37.014.36.001.24]

[Abstract] Heating of power distribution busbars with bolted joints by electric current is analyzed, for the purpose of design in accordance with the 1984 All-Union State Standard 8024 specifying maximum temperatures in 35°C ambient air or in accordance with Rules for Installation of Electrical Equipment in 25°C ambient air. Calculations are based on the nonlinear differential equation $Sd(\lambda(Theta)dTheta/dx)/dx=Q(Theta)-I^2R_a(Theta)$, describing the steady-state temperature distribution along a current-carrying bare conductor in air (θ- temperature of busbar, θ_a- temperature of ambient air, $Theta=\theta - \theta_a$, S - cross-sectional area of busbar, λ - thermal conductivity of busbar material, Q - heat flux transferred from busbar surface to air per unit area in a unit of time, I - effective current, R - electrical resistance of busbar per unit length, x - longitudinal space coordinate. For a bolted busbar

$$Q = Q_c + Q_r - Q_s Q_c$$

- heat dissipated by natural or forced convection, Q_r - heat flux dissipated by radiation according to Wien's law, Q_s - absorbed solar heat), heat dissipation from the collecting bar and from the bolted joint being disregarded without an appreciable error. Convection of heat is described by known semiempirical expressions applicable to indoor or outdoor distribution apparatus with typically tubular bolted busbars. The boundary conditions for the equation are

$$Theta|_{x=0}=\theta_{max} - \theta_a$$

and $Theta_\infty=Theta_\infty$. This nonlinear boundary-value is solved by conversion to the nonlinear difference equation $(Theta_{i-1} - 2Theta_i+Theta_{i+1})/h^2=Q(Theta_i) - I^2R(Theta_i)$ and subsequent application of Newton's method. The problem has been thus solved for a wide range of busbar characteristics covering various materials (copper, aluminum, 19157 aluminum alloy) and air characteristics covering various climates. An approximate analytical solution to that nonlinear differential equation for engineering design purposes can be obtained by reducing it to the $d^2Theta/ dx^2 - m^2 Theta=A$ form ($A=(Q_s+ I^2 R/(\lambda S)$, $m^2=w/S\lambda$), where $w=(Q_s+ I_{allw.cont.} R_{allw.cont.})/Theta_{allw.cont.}$ (allw.cont.- allowable continuous temperature of bolted joints: 120°C for copper, 90°C for aluminum). On the basis of the solution $Theta=Theta_\infty+(Theta_0-Theta_\infty e^{-mx}$, with all necessary substitutions, can be calculated the minimum allowable length of branch conductors from the collector busbar to the bolted joint so that its temperature under normal operating conditions will not exceed the maximum allowable. Figures 3; references 9.

Combination Method for Computing the Electromagnetic Field in Induction MHD-Systems

927K0252A Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 1, Jan 92 pp 3-8

[Article by N. Kh. Erkenov, Yu. M. Gorislavets, A. D. Podoltsev, Institute of Electrodynamics, AS USSR (Kiev); UDC 519.725]

[Abstract] A Combination Method using the Boundary Elements Method and the Method of Finite Differences (MFD) for computations of non-stationary electromagnetic field in induction MHD-systems with ferromagnetic cores has been developed. The method proposed in this paper is highly efficient and economical. Since for solution of a problem in a linear limited or unlimited region it is best to apply the Boundary Element method, and in a limited non-linear region the Method of Finite Differences (MFD) is more suitable, the advantages of each individual method can be well utilized by combining the best qualities of the original Methods of the Finite Differences and the Boundary Elements. The merits of the MFD method are particularly useful for resolving multidimensional differential equations into a unidimensional series, which significantly simplifies the computations, reduces the time and the required computer memory for executing the program. The Combination Method was used for computing the electromagnetic fields and forces in a liquid metal of various MHD-devices. A significant reduction in the required computer memory and processing time was achieved by application of the Combination Method for computing the electromagnetic field in solid conductors in the presence of non-conducting ferromagnetic core. Compared to the method of integral equations, the computer memory with application of this method was reduced by a factor of 5-6, and the computation time was reduced by a factor of 3-4. The method and the computation program based on this method retains its rationality with analysis of electromagnetic processes in non-linear conducting media. Figures 5, references 9: Russians 6, Western 3.

Mathematical Model of a Channel Which Synthesizes the Acoustic Noise

927K0252B Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 1, Jan 92 pp 93-102

[Article by D. Buynovskiy; Novocherkassk Polytechnic Institute; UDC 519.725]

[Abstract] A logic is proposed for constructing a mathematical model of a synthesizing channel utilizing the method of linear prediction. The coefficients of prediction are determined for different requirements of the magnitude of errors of the amplitude-frequency (A-F) and phase-frequency (P-F) spectral characteristic of the audio signals. In this model the signal generator consists of n tone generators and a white noise generator. The instantaneous spectrum envelope shaper uses the method of linear prediction with a particular prediction depth. The statement of the problem is to determine all components of the controlling effect on the synthesis channel for the specified instantaneous signal spectrum. All known methods, while using different approaches for the solution of the problem, compute the prediction coefficients which determine the output signal from the synthesis channel with identical errors in the amplitude-frequency and phase-frequency spectral characteristic. However, in the case of a human hearing apparatus, its resolution is different to these signal characteristics. The proposed Synthesis Channel model examines the prediction coefficient with specified A-F characteristics and arbitrary P-F characteristics. Here, the solution which requires a minimal number of the prediction coefficients and a minimal size of these coefficients is selected from many solutions. The described model of the Synthesizing Channel is useful for optimizing the synthesis channel structure for a specified set of instantaneous spectra. Thus, it was used for optimizing the structure of the synthesis channel for reproduction of acoustical images in a cosmic simulator. Figures 3, references 3: 2 Russians, 1 Western.

Synthesis of the Digital Filters for a Programmed Protection of Electrical Power Lines in the 110-330kW Range

927K0252C Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 1, Jan 92 pp 110-113

[Article by G. N. Pashnin, A. S. Saukhatas; Riga Technical University; UDC 519.725]

[Abstract] Using the Tchebycheff polynomials and the least square method, a new approach is proposed for a synthesis of filters, which suppress the exponential components of currents and voltages, and are used in devices for relay protection of the electrical power lines in the 110 to 330kV range. This paper shows a feasibility of providing filtering of acceptable quality by easily realizable non-recursive digital filters with constant coefficients. Computer computations were made for determining the efficiency of the proposed filters in instruments which are used for finding the location of line damage, compared to filters based on Fourier transform. Four hundred cases of short circuits in a 330kV Latvian power line were modeled. Line modeling also included the equivalent circuits consisting of several T-shaped four-terminal networks; the zero resistance dependence on frequency was also taken into account. Current transformer with non-linear magnetization characteristic was also included in the model. The model's shortcoming consists in that the computations were made assuming a constant transient resistance. However, for relatively distant short circuit locations this is acceptable. The results of modeling indicate

smaller percentage of error in determining the distance to the damage location in a 330kV power line when using the synthesized filters compared to the Fourier filters. Tables 2, references 7: 6 Russian, 1 Western.

Informational and Metrological Characteristics of Fourier Transformation Algorithms

927K0183A Moscow IZMERITELNAYA TEKHNIKA in Russian No 10, Oct 91 pp 13-16

[Article by Ya.Ye. Belenkiy and V.V. Potopalskiy; UDC 681.3.06-1/9:681.332.5]

[Abstract] Certification of spectrum analysis by way of Fourier transformation is considered, only the algorithm of its discrete version being programmable on digital computers and its continuous version therefore needing to be converted into the discrete version. Certification of the Fourier transformation for use in spectrum analysis consists of two tasks: certification of the discrete representation which does not depend on the discrete Fourier transformation algorithm and certification of the digital computer with its software as a real physical instrument transducer. First are analyzed the metrological characteristics of the continuous-to-discrete conversion and the systematic error of discrete Fourier transformation. The two basic metrological characteristics of this transformation, functions of the frequency-division error, are the transformation time and width of the influence band (lengthening the computer time reducing the error due to influences and thus the frequency-division characteristics of the filter). The systematic error of discrete Fourier transformation has been evaluated numerically, its discretization component as well as its component due to finite representation time, for a real rectangular pulse signal and thus for a complexly symmetric discrete Fourier transformation. The random error and the ambiguity function are taken into account. The error due to finiteness of the representation time was calculated in various ways, using the direct algorithm, fast Fourier transformation algorithms with thinning in the time domain or in the frequency domain, and the Vinograd algorithm. The results were found not to depend on the choice of algorithm. For subsequent analysis of the informational characteristics of discrete Fourier transformation for the purpose of its certification, as measure of the information content is introduced the product of two measures: $\Delta\nu T$ (ν - frequency or argument of Fourier transform, T - function f(t) representation time) and amplitudinal measure $1/\log_2(1+ 1/\delta)$ (δ - total error). Figures 2, references 4.

Characteristics of Compensation of Instrument Error in Responsor of Phase-Lock Radio Rangefinder

927K0183B Moscow IZMERITELNAYA TEKHNIKA in Russian No 10, Oct 91 pp 18-20

[Article by V.F. Kravchenko and S.B. Medvedev; UDC 621.396.96:621.317]

[Abstract] Compensation of the instrument error in a radio rangefinder with tracking time delay meters in both interrogator and responsor is analyzed, inclusion of these meters operating on the basis of phase-lock automatic frequency control meant to ensure high accuracy of distance measurement. Narrowing the frequency band significantly diminishes the fluctuation error of distance measurement and widens the range of measurable distances, but also increases the instrument error. Compensating the time delay in the interrogator is easy simple and can be done directly at the output of its tracking delay meter. Compensating the time delay in the responsor in such a direct way is impossible, inasmuch as information would have to be transmitted from responsor to interrogator, but can be done by introducing a certain static tracking error equal and opposite in sign to the time delay in the radio channel. The tracking time delay meter in the responsor with such a delay compensation is a closed loop consisting of a time discriminator receiving signals from the frequency converter, a low-pass filter, a tunable oscillator, and a rangefinder signal duplicator. Its time delay compensator includes a rangefinder signal generator, a pilot signal generator, and a summing device. The time delay meter receives signals from the rangefinder signal generator and from the rangefinder signal duplicator, its output signals being switched to the summing device. The latter feeds the sum of calibration voltages to the tunable oscillator. The pilot signal generator receives signals from the responsor transmitter and sends signals to the frequency converter. Based on analysis of the compensation process, the minimum necessary number of compensation cycles is shown to be $m= \log R/\log(1-S)$ (R - instrument time delay after $i \to \infty$ compensation cycles relative to the initial instrument time delay,

$$S= S_{dm}S_{m2}/S_{od}S_{m1}, S_{dm,od}$$

- slopes of conversion characteristics of time delay meter and of time discriminator, $S_{m2,m1}$ - slopes of modulation characteristics of tunable oscillator at its compensation input and at its control input. Inasmuch as $R= (1- S)^i$ (i - number of compensation cycles), compensation is possible only when $0 < S > [2]$, the process being an aperiodic one when $0 < S > [1]$, the process being an oscillatory when $1 < S < 2$, and compensation in a single cycle being possible only when $S= 1$. Figures 2; tables 1; references 7.

Cryogenic D.C. Voltage Divider

927K0183C Moscow IZMERITELNAYA TEKHNIKA in Russian No 10, Oct 91 pp 40-43

[Article by V.I. Krzhimovskiy; UDC 621.317.727.1]

[Abstract] A cryogenic voltage divider has been developed at the Scientific Research Institute of Metrology for use in the new official GET 13-89 primary standard of a volt. Its design is based on series-parallel switching of two resistor groups with a nominal resistance R, the actual resistance of any n-th resistor being $R_n= R(1+\Delta_n)$. The voltage ratio is influenced by the current dependence of the electrical resistance in both series and parallel connections. The number of resistors is the same

in each group and can be varied, m= 3 being typical. The divider consists of a printed-circuit board carrying the resistors soldered on with 40 Sn - 60 Pb solder and a sliding switch, both in a helium cryostat and both surrounded by a double superconductor shield. The divider is fastened to a stainless steel tube which terminates into an aluminum housing for the control mechanism. The insulation resistance between current leads and the inner shield is at least 10^5 MΩ. Provisions are made for shunting the cryoresistors with high-resistance resistors also mounted on that board. The divider operating current is about 2 mA. Essential features of this device are no switching under a high potential, continuity of the current circuit, and simple construction. With proper trimming, it is possible not to change the voltage ratio by more than 10^{-6} when switching the resistor groups. The cryoresistors are wires 0.1 mm in diameter made of a germanium bronze with Ga and Ti admixture, magnetic impurities having been minimized so as to not only ensure a small temperature coefficient of electrical resistivity within the $(1\text{-}2)^{-6}$ /K range when bare but also make their electrical resistance less dependent on the current and on external magnetic fields. Their nominal electrical resistance is about 40 Ω per 2 m length, a tradeoff between low noise and good heat dissipation requirements. They had been artificially aged at 500-550°C under vacuum. They are wound and insulated on a brass bobbin with a coefficient of linear thermal expansion close to theirs. The switch with 13 contactor pairs is a cryogenic device, as required for switching the resistor groups from series to parallel in the superconducting modem under currents of at least 5 mA. The contactors are quasi-metallic, a thin 20 nm thick oxide layer forming a weak-link Josephson junction the critical current for which is determined by electrochemical processes. The design of the contactors was based partly on the "thermal" contact theory. The divider error is caused by imprecise resistor trimming, temperature gradient and fluctuations, current leakage through insulation, and the aforementioned current dependence of the electrical resistance. The corresponding four error components have been estimated by statistical methods (current dependence of electrical resistance), by other methods (imprecision of resistor trimming), or by both statistical and other methods (current leakage, temperature gradient and fluctuations). Figures 2; tables 1; references 4.

Measurement of Average Values of Periodic Voltages by Digital Processing of Signals

927K0183D Moscow IZMERITELNAYA TEKHNIKA in Russian No 10, Oct 91 pp 43-45 [Article by I.N. Zhelbakov and A.V. Yankov; UDC 621.317.083.92]

[Abstract] Digital processing of periodic signals for determination of average and effective voltages is considered, the fastest way of determining the average voltage being to measure it within the length a time equal to the signal period or a multiple of that period. A method of minimizing the attendant measurement error is shown, based on representation of the average voltage as the result of weighted integration:

$$v_{aver} = \mathrm{Int}_0^T g_T(t,T)v(t)dt,$$

where T is the signal period and g_T is the weight function dependent on the reading of that period T(meas). For digital processing of a signal, this integral is replaced with a discrete weight function dependent on the reading of the signal period T(meas):

$$v_{aver}^{meas} = \Sigma_{i=1}^{N} g_{meas}(i,N)v(iT_{dis})$$ (g_{meas} - discrete weight function approximating g_T on the interval $(i- 0,5)T_{dis}$- $(i+ 0.5)T_{dis}$, T_{dis} - discretization interval, N- number of readings of the discrete weight function dependent on the discretization interval $T_{(dis)}$ and on the form of the approximating weight function g_{meas}. In the case of a constant discretization interval one may represent the discrete weight function as a sum $g_{meas}+ \Delta g$, both terms depending on the signal period T and on the relative error of its reading. Assuming then that

$$\Sigma_{i=1}^{N} \Delta g(i,N)v(iT_{dis}) \approx \mathrm{Int}_0^{T(meas)} \Delta(t,T_{meas})\, v(t)dt),$$

the error of measurement of the average voltage - referred to the maximum signal voltage - is then the sum of two components: error of signal period reading and discretization error. An algorithm is constructed which simultaneously reduces the error due to inaccurate measurement of the signal period and the discretization error. Practical problems arising in its implementation (static and dynamic errors of analog-to-digital conversion, noise due to finite word length, intrinsic noise of computer hardware) are not discussed, inasmuch as they have already been thoroughly treated in the technical literature on this subject. Figures 2; references 7.

Optimization of Conditions for Measurement of Electromagnetic Compatibility Parameters Within Transition Zone of Radioelectronic Systems on Basis of Accuracy Criterion

927K0183E Moscow IZMERITELNAYA TEKHNIKA in Russian No 10, Oct 91 pp 45-47

[Article by G.D. Mikhaylov and S.N. Panychev; UDC 621.396.677.73]

[Abstract] Measurement of electromagnetic compatibility parameters in radioelectronic systems is analyzed, adequate accuracy being usually ensured by making this measurement in the Fraunhofer region so that the field of an electromagnetic radiation wave may be regarded as a locally plane one. There are technical difficulties associated with measurement of UHF signals at far distances, however, high cost and low sensitivity among them. The feasibility of making this measurement within the transition zone is therefore considered, it being necessary to estimate and minimize the error in this case. The four additive mutually independent major components of the total systematic error σ_Σ are: 1) phase error σ_1 caused by deviation of the phase front from a plane one; 2) power error σ_2 caused by appearance of spurious radiation waves and reception channels which lower the signal-to-noise ratio at the instrument receiver input; 3) shielding error σ_3 caused by imperfect shielding of the instrument receiver; 4) earth effect error σ_4 caused by rereflections by the ground surface. Formulas have been derived and experimentally validated for estimating

each of these four component errors, the phase error and the three other errors being always of opposite signs. The phase error is $\sigma_1 = -m_1 \chi^{-2}$ (m_1- scale factor, $\chi = R\lambda/D^2$, R - measuring distance, λ - radiation wavelength, D - diameter of receiver antenna aperture), the generalized dimensionless parameter χ being maximizable for minimization of this error. The other three errors, with respective scale factors $m_{2,3,4}$, depend on the receiver passband ΔF and its squareness ratio γ as well as on the bandwidth W of the radiation spectrum. In the best and simplest case $\Delta F = W$ it is possible to minimize the total systematic error σ_Σ by optimizing the directive gain of the instrument receiver antenna, the receiver sensitivity, and only some other influencing factors only, as demonstrated by the dependence of that total error σ_Σ on the optimization parameter χ and implicitly on the directive gain of the instrument receiver antenna. The theoretical feasibility analysis is supported by numerical calculations for specific values of instrument parameters and of signal transmitter parameters. Typically, the appropriate measuring distance R is within 2-20 m with χ within the 0.2-2.0 range for measurement of 10 cm waves (G4-9 transmitter) with an instrument whose receiver antenna (P6-23A) has a D= 1 m aperture and which includes an SK4-75 spectrum analyzer. Figures 2; references 10.

Method of Compensation in Radio-Pulse Phase Meters Built With Charge-Coupled Devices Pulse Phase Meters

927K0183F Moscow IZMERITELNAYA TEKHNIKA in Russian No 10, Oct 91 pp 47-49]

[Article by A.I. Fendrikov; UDC 621.317.373:621.317.772]

[Abstract] Measurement of phase shifts between radio pulses with phase meters by the compensation method is considered, of particular interest being phase meters built now with commercially produced hybrid digital-analog delay lines on charge-coupled devices. Such a phase meter with compensation includes a frequency synthesizer as gage with two analog shift registers forming its two respective output channels and has a calculator of cumulative phase shift inserted between the frequency synthesizer and digital phase indicator. The operating phase characteristic of one analog (channel 1) shift register corresponds to the maximum word length, the operating phase characteristic of the other analog shift register (channel 2) corresponding to any other among the family of phase characteristic. Each analog shift register feeds its output through a low-pass filter into a null indicator which in turn feeds its output back to the frequency synthesizer. The operation of this phase meter is demonstrated on and analyzed for two coherent sinusoidal radio pulses of equal durations but with a time difference between them. The cumulative phase shift is compensated by means of an additional time delay of the two radio pulses in the phase meter channels, the leading radio pulse being delayed longer than the lagging one. The phase meter operates can operate in two compensation modes, as determined by the frequency synthesizer and the cumulative phase shift calculator-indicator, either in the "initial undercompensation" mode with the ratio of the time delays of the two pulses remaining in the first cycle same as the ratio of their original time delays or in the "initial overcompensation" mode with that ratio in the first cycle inverted. In the first undercompensation cycle is effected a rough compensation of the cumulative phase shift with an error not larger than one radio-pulse duty cycle period, its full compensation then taking place in the second cycle. Operation in the "initial overcompensation" is analogous but with an appropriately different encoding scheme. The main error of this phase meter is the error of both analog shift registers and of their low-pass output filters, an error smaller than 1° being attainable according to the results of performed experiments. A compensation range of 32π is feasible with model 593BR1 analog shift registers (maxf= 1 MHz upper limit of clock frequency, d= 5 minimum number of radio-pulse period discretization points) and an F= 10 kHz radio-pulse duty cycle frequency. Figures 2; references 5.

High-Precision Apparatus for Measurement of Complex Reflection Coefficients for Electromagnetic Waves in Rectangular Waveguides

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[Article by V.G. Alyabyev, O.F. Kiselev, A.V. Milnikov, V.D. Frumkin (deceased), B.A. Khvorostov, and V.G. Chuyko; UDC 621.3.092:621.372.9]

[Abstract] In the year 1990 the All-Union Scientific Research Institute of Physical Engineering and Radio Engineering Measurements completed the development and certification of a high-precision apparatus for duplication and transfer of the unit measure of the complex reflection coefficient for electromagnetic waves in rectangular waveguides. The apparatus is an automatic circuit analyzer designed to operate at any set frequency within the 2.59-37.5 GHz range, using a quarter-wave segment for full calibration and using DK1-16,DK1-12 vector voltmeters for indication. Measurements are made in standard waveguides with 72 x 34 mm^2, 58 x 25 mm^2, 48 x 24 mm^2, 40 x 20 mm^2, 35 x 15 mm^2, 28.5 x 12.6 mm^2, 23 x 10 mm^2, 17 x 8 mm^2, 16 x 8 mm^2, 11 x 5.5 mm^2, 7.2 x 3.4 mm^2 cross-sections. With a voltage standing wave ratio VSWR $\geq$ 1.2, the measurement range covers complex reflection coefficients with a 0-1 modulus and a 0-360° phase. The standard deviation of VSWR and phase readings are 0.3 percent 0.3° respectively. The nominal VSWR in five gages transmitting the measure of a complex reflection coefficient is 1.05, 1.2, 1.4, 2.0, 4.5 respectively. Tables 1.

Components of Systematic Error of Electric Field Intensity Meter With Stub Antenna

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[Article by V.I. Tokatly; UDC 621.317.328.089.6]

[Abstract] Instruments for measuring the intensity of alternating electric fields in the 0.01-30 MHz frequency range consist essentially of a stub antenna, with a counterweight, which converts the field intensity into an alternating voltage, a matching device, an a.c. voltmeter, and a high-frequency cable connecting the voltmeter input impedance to the output of the matching device. Typical such meters are the FSM11 and the HFH2 made in Germany and the NLMZ made in Poland. The principle of measurement, common to all makes, is analyzed for systematic error on the basis of L-antenna theory. The instrument with a stub antenna is accordingly regarded as a linear antenna standing above a half-space occupied by a dielectric medium with a finite permittivity. The theory is applied to both transmitter and receiver modes of antenna operation, then to a specific model of an instrument with an L-antenna consisting of straight segments: a vertical segment simulating the stub antenna, a grounding conductor, equally long horizontal segments (m= 1,2,...,M) simulating the counterweight in the form of an open equiangular polygon, one horizontal and two vertical segments simulating the high-frequency cable. The antenna stands in the upper half-space occupied by a dielectric medium, the lower half-space being being occupied by a different dielectric medium. In the quasi-steady approximation the antenna dimensions are assumed to be smaller than the wavelength of the electric field and the current distribution in each segment to be linear. Considering that the voltmeter reads r.m.s. voltages, performance calculations based on a more precise and realistic definition of a stub antenna as an asymmetric one consisting of not only a stub but also another arm of arbitrary form yield the systematic error of such an electric field intensity meter. This error consists of two components: one due to deviation of the true value of the calibrated field-to-voltage conversion factor $K_a = 1/|$ during measurements from its certified value, one due to the antenna asymmetry. Its asymmetry causes the conversion vector not to be vertical but to have a horizontal component, the magnitude of the latter determining the magnitude of this error component. Figures 2; references 6.

Error Caused by Mismatch During Comparison of Noise Millimeter-Wave Signals

927K0160C Moscow IZMERITELNAYA TEKHNIKA in Russian No 11, Nov 91 pp 52-54

[Article by Yu.V. Kistovich, G.V. Korovko, and O.G. Petrosyan; UDC 621.317.34.089.68]

[Abstract] The performance of a millimeter-wave receiver as comparator for transfer of the unit measure of spectral noise power density is analyzed, noise signals being transmitted to it through both main and mirror channels with a 0.5-2 GHz wide intermediate-frequency passband each. The comparator consists of a receiver behind a waveguide line of given length, two standard oscillators with known levels of spectral noise power density or known effective noise temperatures, and the oscillator whose effective noise temperature is to be checked against that of one of those two oscillators. Calculations are based on the standard comparator equation with a multiplier accounting for the two pertinent radiometer characteristics, its passband and complex reflection coefficient. This multiplier is simplified by disregarding products of complex reflection coefficients squared. In this approximation is then evaluated the relative error due to transmitter-receiver mismatch, this error being proportional to $L/\Delta f$ (L - length of waveguide line, Δf - i-f passband). The error due to mismatch is shown to be an oscillatory function of the waveguide length and is numerically estimated as such for a $\Delta f = 1$ GHz wide i-f passband. Figures 1; tables 1; references 6.

Design of Piezoelectric Transducers

927K0160D Moscow IZMERITELNAYA TEKHNIKA in Russian No 11, Nov 91 pp 54-56; UDC 537.228.1.087.92]

[Article by V.M. Bogomolnyy; UDC 537.228.1.087.92]

[Abstract] The design of toroidal piezoelectric transducers is analyzed, devices with a toroidal structure being selected because of their high sensitivity and strong electromechanical coupling. A toroidal shell sector with a narrow gap and polarized in the thickness mode is considered, its dimensions being defined in terms of two angular coordinates: cirumferential coordinate $0 \leq \theta < 2\pi$ (open circle) and meridional coordinate $0 \leq \varphi \leq \pi/6$. Its $\varphi = 0$ edge is rigidly constrained by a support clamp, but its $\theta = 0$ edge and all other surfaces are free of mechanical stress. The analysis is based on the fundamental equation of the linear membrane theory and on Laplace's field equation with appropriate boundary conditions. Solution of the membrane equation yields the width of the zone affected by the free $\theta = 0$ edge, which in turn determines the optimum circumferential dimensions of the toroidal shell sector. Solution of the Laplace equation then yields the characteristic function of the meridional coordinate. This function is known from solution of the analogous problem for a closed toroidal shell ($0 \leq \theta \leq 2\pi$) but the boundary of the solution region in this problem is not known. In order to determine that boundary, it is necessary to minimize the functional which represents the surface area under constant pressure by the free stream of acoustic fluid. The maximum width of the zone affected by the free $\theta = 0$ edge can be determined from the coefficients in the membrane equation. As a specific example is considered design optimization of a narrowly open toroidal shell sector of TsTS-19 strontium zirconate-titanate ceramic for a radiator-transducer operating under +/-200 V applied to its electrodes. Figures 2; references 11.

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